COLLEGE OF ENGINEERING CORNELL UNIVERSITY

the Cornell engineer

NOVEMBER, 1954

VOL. 20, NO. 2

25 CENTS

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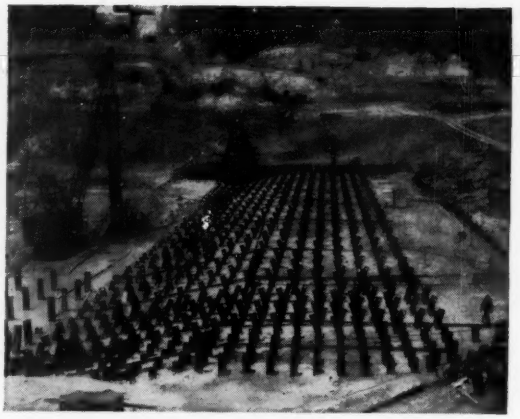

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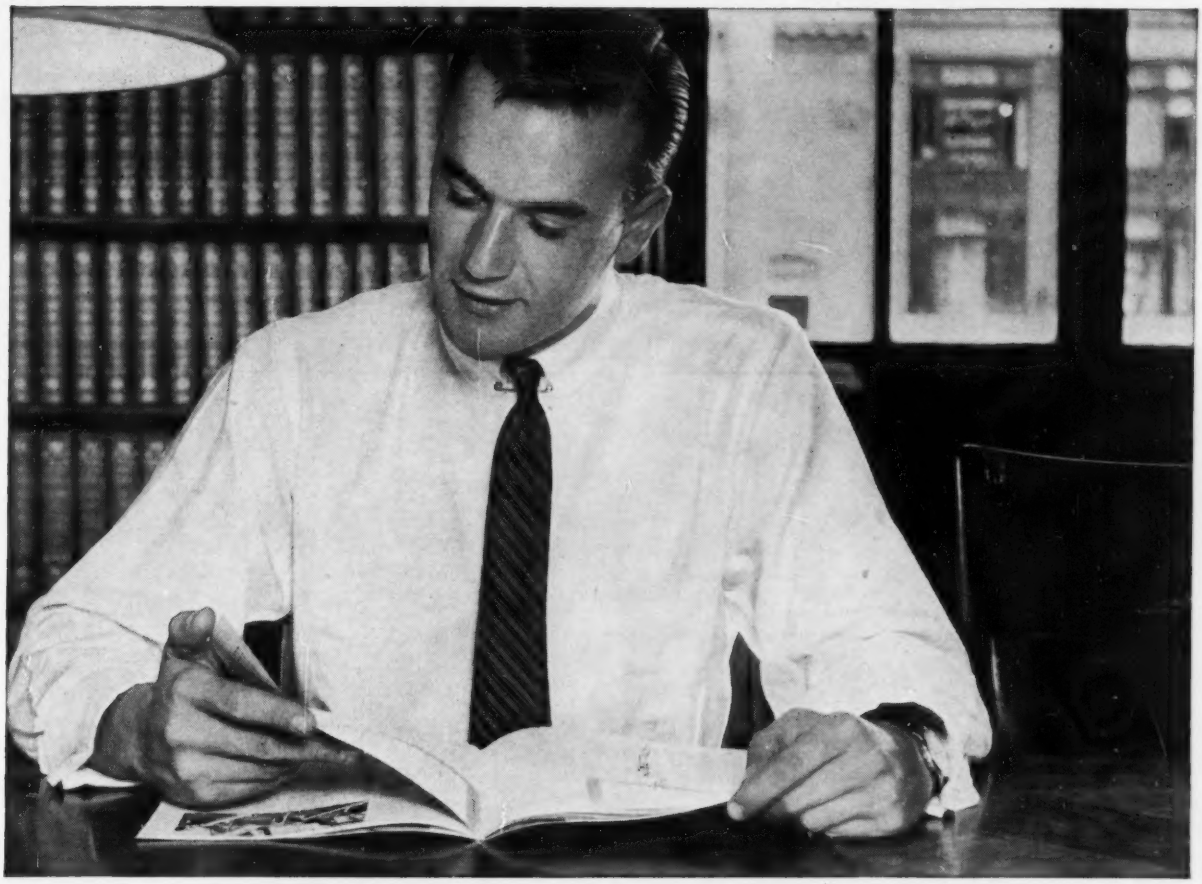

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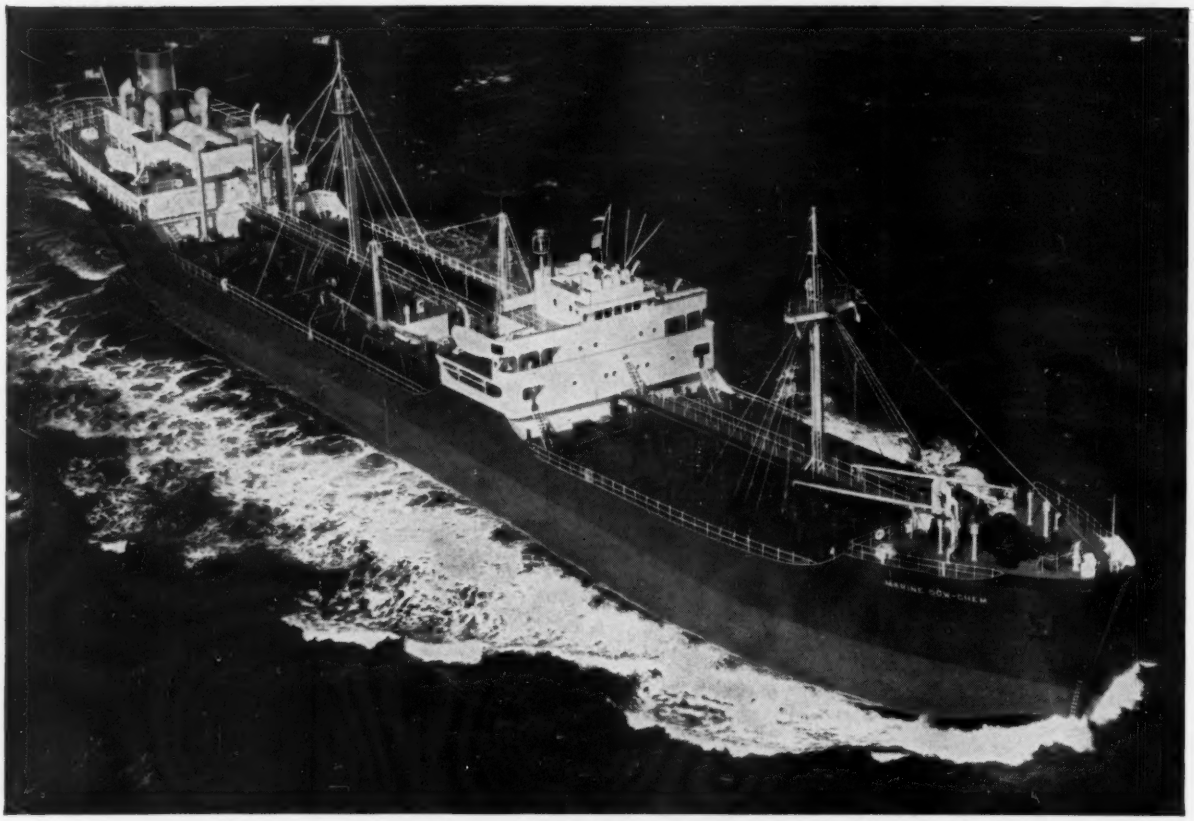

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A MESSAGE TO
COLLEGE ENGINEERING
STUDENTS

from J. M. Wallace, Manager, Meter Div.,
Westinghouse Electric Corporation
University of Pittsburgh, 1935

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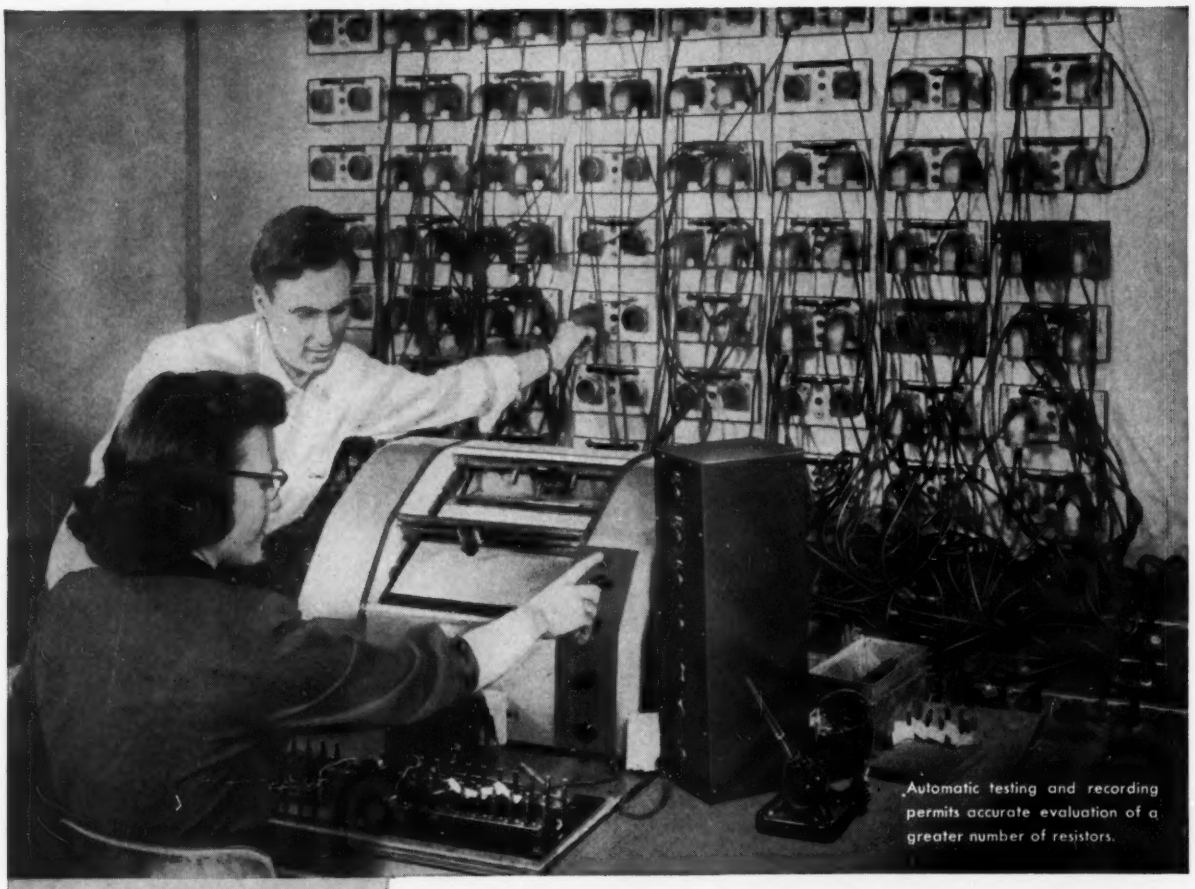

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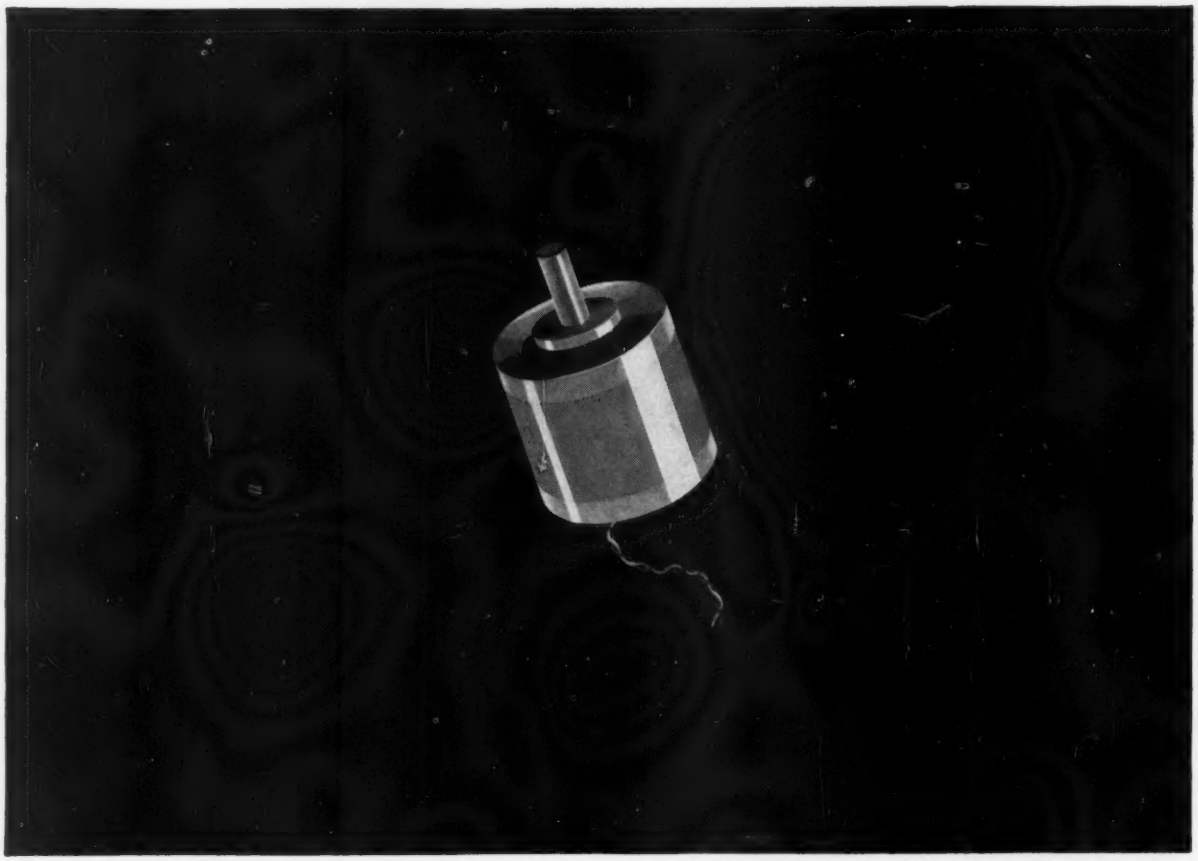

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COVER—University Hall—new men's dormitories.
(See Cover, Dec. 1953)

—Alan Cohen

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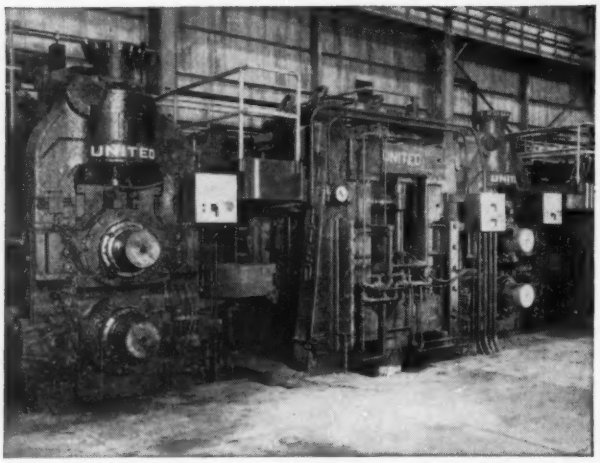
Another page for **YOUR BEARING NOTEBOOK**



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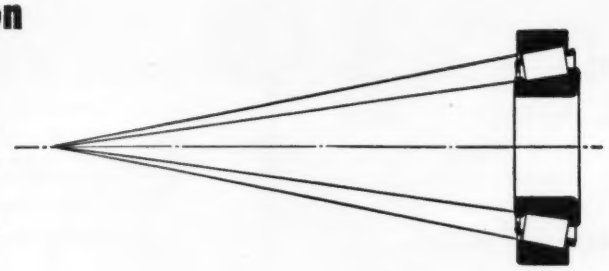

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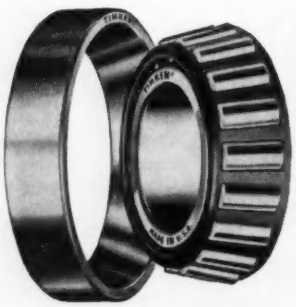

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WHO ARE INDUSTRY'S TOP YOUNG SCIENTISTS ?

Ten men between the ages of 26 and 40 were featured in a recent national magazine article which presented a portrait of the young scientist in America today. These particular men are a sample of the most brilliant young scientific minds in industry.

It's interesting to note that three of the ten are with Bell Telephone Laboratories, three with General Electric and one each with four other companies.

The variety of opportunity in research and other phases of telephone work has always attracted an unusually high percentage of the nation's best young men.

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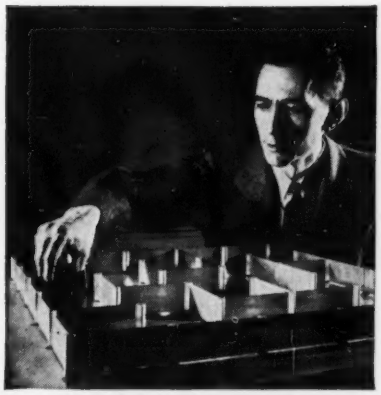
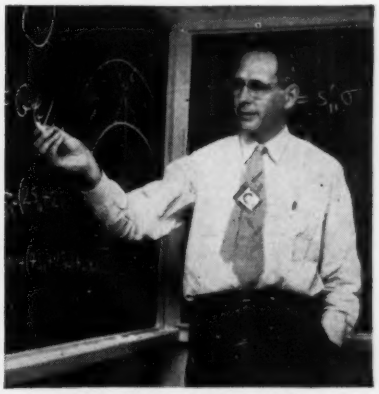
THREE OF THE TEN ARE AT BELL TELEPHONE LABORATORIES—



Mathematician Claude Shannon won fame for his Communication Theory

Physical Chemist William Baker introduced new concepts that have improved synthetic rubber and fibers



Physicist Conyers Herring is known for his understanding of the quantum mechanics of the solid state

BELL TELEPHONE SYSTEM

Cavity Walls

by JEROME QUINN, C.E. '54

The University dormitory group of six four-story buildings, which is rapidly nearing completion below East Avenue, is thought to be the tallest set of buildings using cavity wall construction with no supports for the entire height of the structure ever attempted in this country. With such a distinctive structure in existence on the Cornell campus, a closer look should be given at cavity walls and any advantage considered that they might have over the other types of wall construction.

A cavity wall simply consists of two vertical walls, separated by an air space, with no connection other than brickwork at the floor level and metal tie-rods throughout the entire height. This is not to be confused with solid walls composed of units such as cinder blocks or structural clay tiles, which are hollow in themselves. Nor is it meant to include veneered walls which consist of two dissimilar materials with no space between them.

Any wall which fits this broad definition may be considered a cavity wall. The university dormitories are outstanding in that they are reputed to be this country's tallest cavity walls with no brickwork at the floor level, the two walls being bridged only by metal tie-rods. Tall cavity walls probably exist in other countries, especially England and Australia, where such design was popular before World War II. It has not been until recently that cavity walls have been put to frequent use in the United States.

Before listing the particular advantages of cavity walls, some requirements of all walls which are essential to successful construction will be enumerated:

1. Impermeability to moisture.
2. Insulation from heat and cold.
3. Economical construction.
4. Weather resistance.
5. Ability to support a designed load.
6. Fire resistance.

Several other characteristics are usually desirable in a wall but are not absolutely necessary. These include, among others, sound absorption, adequate light transmission, and esthetic value.

Cavity walls present a unique method of meeting the first requirement of a good wall: to prevent moisture entrance. The use of cavity walls actually permits the water to penetrate the outer wall, but the air space contains a metal tie-rod, spaced every few square feet, which prohibits the water from reaching the inner wall. This tie-rod or drip anchor, as it is called, consists of a short metal rod with a small v-shaped dip at its center, which is fitted across the air space (Fig. 1.) Any moisture that does form inside the cavity wall will eventually condense and start to fall; the v-shaped dip in the tie-rod is designed to gather all these drops of moisture into the one axis formed by the dips of all the tie-rods, thus compelling them to fall down this axis to the bottom of the cavity without reaching the inner wall.

Leaks through an ordinary brick wall, such as used for the outer plane of the cavity wall, occur in almost any part of the wall and may be caused by various defects. The greatest cause of leakage is the shrinkage of the mortar from the brick due to evaporation of the moisture from the wet mortar. Ordinary bricks also absorb water until they become saturated, thus providing a passageway directly through the brick. The explanation of the absorption is one of a combination of the force of capillary action, assisted by gravity and wind pressure. Also, such items as faulty construction around windows or faulty masonry contribute to leakage.

Leaks due to mortar shrinkage may be lessened by the utilization of prehydrated cement, a cement which has been allowed to dry for approximately two hours before application. Leakage through the brick itself may be stopped by glazed brick surfaces if economically feasible. However, these corrections cannot prevent all water from entering; hence, the drip anchors in the cavity are relied on to minimize the resulting moisture penetration by its action of forcing moisture to drop to the bottom of the cavity.

Water drainage

When at the cavity bottom, water is allowed to drain out by means of weep holes, which are openings in the mortar. These weep holes are formed by leaving a metal rod or a greased cord in the wet mortar, and, upon removal, when the mortar begins to set, a hole is left in the space which the rod or cord had occupied.

Two distinct types of drip anchors were used in the University dormitories. The first (Fig. 1) was a ¼-inch round bar with a maximum length of 8 inches plus 2-inch bends on both ends to grip into the walls. While this first kind was to extend from wall to wall, the second type was made to connect wall to column. It was exactly the same as the first, except one of its 2-inch bends was replaced by a bent hook which fitted into a dovetail slot in the column. Specifications called for these drip anchors to be placed 12 inches from all openings, and no vertical or horizontal distance between ties to exceed 24 inches.

Phillips Hall, School of Electrical Engineering is near completion, as another engineering school moves to the south side of Campus.

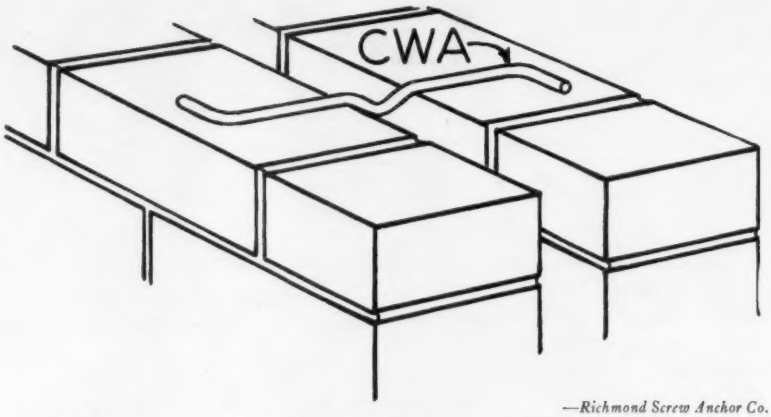
—Matt Starr

However, this is not a fool-proof scheme for impermeability, for it is possible that moisture in the air space will not condense until it reaches the inner wall (thus bypassing the drip anchors), and, therefore, the usual methods of waterproofing are still used to good advantage.

Cavity walls comply with the second wall characteristic, insulation from heat and cold, by the elementary physics principle that air is the best insulator. Since air provides an extremely low conducting surface for heat transfer, radiation, and convection, secondary means at best, are the only vehicles available to transport heat across the air gap in the cavity walls.

The amount of heat transferred by radiation from the outer wall is directly proportional to the temperature difference between the surrounding air and the wall itself. In the case where we are trying to keep heat in the building, the outside wall will not be sufficiently warm, due to the lack of a conducting surface between the inner and outer walls to provide this temperature variation necessary for radiation. Likewise, in trying to keep heat out of the building, we find that the air space will prevent heat from reaching the inner wall where it might radiate to the cooler inside.

Heat loss due to convection is negligible, since all currents able to move in the restricted cavity are limited in their effect. Tests have been conducted which prove that as the cavity width approaches 4 inches, the space becomes sufficiently wide to allow the motion of air currents great enough to convect heat. These same tests demonstrate that widths less than 2 inches afford an ideal opportunity for dripping mortar to form a bridge across the cavity. The air space is therefore limited to between 2 and 4 inches in width.[1]

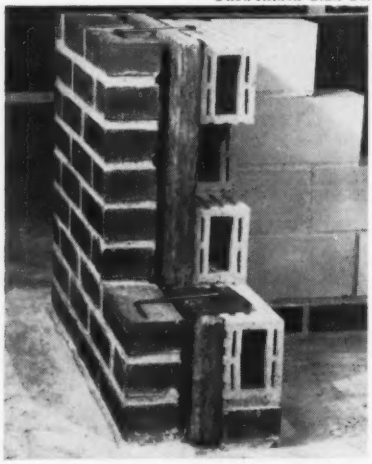


—*Richmond Screw Anchor Co.*

Cavity Wall Anchor. This device is used to strengthen the bond between the inner and outer walls of cavity construction.

10-inch brick and tile cavity wall with 1½-inch mineral wool insulation in air space. Insulation is placed against inner wall, leaving an inch air space between insulation and outer wythe of masonry.

—*Owen Illinois Glass Co.*



Air space filled with insulation

Insulation has sometimes been used to fill the air space of cavity walls for (1) extremely cold climates, (2) buildings where the inside plaster finish, a good insulator, has been removed for decorational purposes. To successfully use insulation in the cavity without ruining the principle of a moisture barrier, the insulating material must either be moisture-proof in itself or must not occupy the entire air space (Fig. 2). Of course, further insulation of this nature is an additional expense in cavity wall construction.[2]

Economy of construction is the third consideration. Here there is much to be argued whether or not cavity walls actually are cheaper than regular walls. At first inspection we would be tempted to note the number of bricks that were saved by the leaving of the air gap as an appreciable financial gain.

While the air space does allow a definite saving in brick cost, it also introduces another expense not present in normal wall construction. For the cavity, if it is to remain a hollow cavity, must be kept free of mortar droppings. Since it would be too presumptive to expect bricklayers not to spill anything down the cavity, a system was devised to catch wet mortar before it could fall to the bottom. This idea, used in the University dormitories, consists of placing a thin slat of lumber, the approximate width of the cavity, down between the walls and resting it on the top layer of metal tie-rods which extend across the air space. The majority of the falling mortar is caught by this slat of lumber, which is hauled up by wires or ropes to be periodically emptied. As the wall is built progressively higher, the lumber is moved upward, always resting on the top layer of tie-rods.

This method does not catch all mortar, due to the fact that it is extremely difficult to obtain a perfect fit between the lumber and the air space. Therefore, three bricks are left out of the base of the outer wall at short intervals to serve as cleanout holes. These holes enable workmen to remove any mortar not caught by the boards.

Before discussing the last wall characteristic, fire resistance, we should have some idea of how fire resistance is measured in the laboratory. The test consists of exposing one side of a test wall of about ten feet square to the heat of a furnace of known temperature. Resistance is then measured in the number of hours required to bring about a specified temperature rise from the side exposed to the furnace to the unexposed side. For some types

(Continued on page 46)

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or

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To those interested in advanced academic study while associated with important research and development in industry, Hughes offers two separate practical programs:

HUGHES COOPERATIVE FELLOWSHIP PROGRAM

for Master of Science Degrees

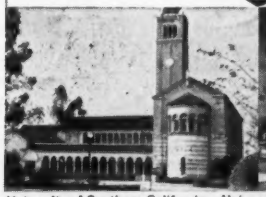
A program to assist outstanding individuals in studying for the Master of Science Degree while employed in industry and making contributions to important military work. Open to students who will receive the B.S. degree in Electrical Engineering, Physics or Mechanical Engineering during the coming year, and to members of the Armed Services honorably discharged and holding such B.S. degrees.

Candidates must meet entrance requirements for advanced study at the University of California at Los Angeles or the University of Southern California. Participants will work full time during the summer in the Hughes Laboratories and 25 hours per week while pursuing a half-time schedule of graduate study at the university.

Salary is commensurate with the individual's ability and experience. Tuition, admission fees and books for university attendance are provided. Provision is made to assist in paying travel and moving expenses from outside Southern California.

HOW TO APPLY

for the Hughes Cooperative Fellowship Program: Address all correspondence to the Committee for Graduate Study



University of Southern California

University of California at Los Angeles

THE HOWARD HUGHES FELLOWSHIPS

in Science and Engineering

Eligible for these Fellowships are those who have completed one year of graduate study in physics or engineering. Successful candidates must qualify for graduate standing at the California Institute of Technology for study toward the degree of Doctor of Philosophy or post-doctoral work. Fellows may pursue graduate research in the fields of physics or engineering. During summers they will work full time in the Hughes Laboratories in association with scientists and engineers in their fields.

Each appointment is for twelve months and provides a cash award of not less than $2,000, a salary of not less than $2,500, and $1,500 for tuition and research expenses. A suitable adjustment is made when financial responsibilities of the Fellow might otherwise preclude participation in the program. For those coming from outside the Southern California area provision is made for moving and transportation expenses.

HOW TO APPLY

for the Howard Hughes Fellowships in Science and Engineering: Address all correspondence to the Howard Hughes Fellowship Committee

California Institute of Technology

HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES

Culver City, Los Angeles County, California

Growth of the American Telegraph System

by HOWARD P. CORWITH, M.E. '16

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When Annie Ellsworth, daughter of the U. S. Commissioner of Patents, selected the words for the first public telegram on May 24, 1844, she probably had no idea of the far-reaching effect of the phenomena she was about to witness; yet the phrase was quite appropriate. For this was the initial demonstration of the usefulness of electric energy. The telegraph, crude as it was at that beginning, had brought electricity out of the laboratory for its first practical application, turning the toy of the physicists into a working medium for the benefit of the public and commerce.

The organizers of the American Institute of Electrical Engineers themselves were largely telegraph men. At the organizational meeting in 1884, 21 of the 25 founders were associated with the telegraph industry. Norvin Green, the first president of the Institute, was president of Western Union at the time. Franklin Pope, the second president of the Institute, was also a telegraph man during the early period, while other electrical engineers exerted important influence on the activities of the organization. In fact, it is told that as late as 1904, when Andrew Carnegie, an ex-telegrapher himself, gave upwards of a million dollars for the construction of the Engineering Societies Building in New York, he remarked to Secretary Pope — "Well! The telegraph boys will now have a comfortable place to meet." A surprising number of men who distinguished themselves in various fields of endeavor had their first contact with the commercial world as employees of the Telegraph Company. These include such diverse personalities as Roy A. Young of the Federal Reserve Bank, George Bancroft of the movies, John McCutcheon of New Jersey political fame, and Glenn Curtiss, the aviation pioneer. It was only natural that this should be true since, as the first useful assignment of electricity, the telegraph seemed a mysterious, strange, and wonderful medium, highly attractive to adventurous youth.

It was more than twenty years after the inception of the telegraph before the electric illumination field was opened by Brush and Thompson and fulfilled by Edison, or the electric power industry came to flower with the development of Gramme motor-generators. Within these years the telegraph had spanned the continent, stitching together the growing Eastern seaboard cities and the fabulous Western frontier with a thin strand of communication; a strand beset by hostile Indians, toppled by buffalo, sometimes even sabotaged by evil-doers for their own ends, but always back in service again keying and sounding out the commerce of the nation.

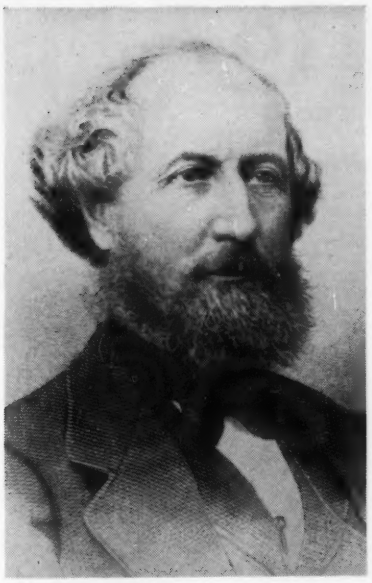
The Atlantic Cable

And the benefit of the telegraph was not only national, but international. Early in 1854, Cyrus Field, another telegraph pioneer, dared to think of a submarine telegraph cable spanning the Atlantic from Newfoundland to England. Refusing to accept defeat after repeated failures, in 1866 he finally succeeded in laying a practical cable, bringing instant communication with Europe that has since been continuous. His perseverance in the face of adversity and ridicule at last won him the right to be listed with those other immortal pioneers whose faith was boundless.

It is difficult to avoid saying "if it hadn't been for the telegraph—", but we know the phrase probably would not hold true. There were too many minds working on the electrical phenomenon for the art to stay submerged; yet certainly the inception of the telegraph hastened the application of electricity pointing the way to other work-a-day purposes. The operation of the telegraph required long lengths of wire. It had to be insulated, magnets de-

About the Author

Howard P. Corwith, a graduate of Cornell University, became an Engineering Assistant in the Traffic Department of Western Union in 1916. He gained wide experience in telegraph operations as multiplex supervisor in the New York vision, Engineering Department, at office; head of the Electronics Division, Engineering Department, at Water Mill Laboratory, which he had established; and research director for many new developments. Mr. Corwith became Assistant Chief Engineer in 1943, Director of Research in 1946, and Vice President in charge of Development and Research in 1949. He is a Fellow of the AIEE, IRE, and a Past President of the New York Electrical Society.



Cyrus Field, who first conceived and zealously promoted the idea of a trans-Atlantic cable, became Vice-President of the Atlantic Telegraph Co., which was reorganized as the Anglo-American Telegraph Co. and finally laid the successful cable of 1866.

signed and dependable batteries had to be found. Problems of electric circuitry had to be met and solved.

Ezra Cornell, one-time plow salesman, evolved the open-wire circuit with glass "door knob" insulators out of pure necessity when the underground pipe circuit devised by Morse developed faulty insulation while being installed. Edison, whose genius was to touch so much of our home life as well as the needs of the electrical industry, did his early inventing on telegraph instrumentation and was eventually able to set up laboratories, culminating in his Menlo Park "Magic Shop" with $40,000 paid by Western Union for his Universal Ticker.

Edison obtained his early telegraph experience with Western Union lines along railroads. Without the railroads, the development of our inland country would have been a tortuously slow process. Without the telegraph the "Iron Horse" would have faced tremendous obstacles. As early as 1851, pioneered by the Erie Railroad, the dispatching of trains by telegraph was undertaken, opening up the single-track lines of that day to much more traffic than could have been handled otherwise. Since the railroads, with their long trackways, were so in need of rapid communication, and the telegraph was so in need of rights-of-way to set poles, the two joined forces and grew up together all over the country. Both utilities were needed at the same places, the centers of commerce, and so one supplemented the other.

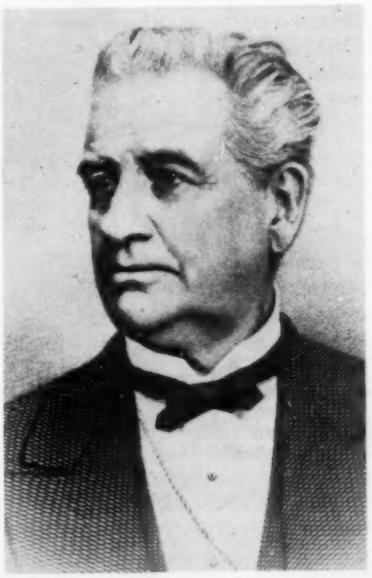
In villages and towns, the sounders clicking in the railway station and the operator in a green eyeshade handling a Morse key were for decades symbolic of Western Union. One occasionally discovers a Morse wire today but what a revolutionary change has taken place in telegraph since the days of its inventor!

The essential purpose of the telegraph from the very beginning was to provide quick communication for business, the dissemination of news, and the functioning of government. During the early period of our history, communication traveled at a snail's pace. Couriers could depend only upon the speed of horse-relays and their own endurance to reach far distant points and even in the East the long hauls by train and boat were not fast enough for the increasing needs of commerce and industry. The first short line individual telegraph companies did little to alleviate this condition. Hiram Sibley, founder and first president of Western Union, foresaw that only chaos could be the result of ruinous competition between short lines. He therefore merged many small companies into what was called Western Union, an integrated telegraph company that filled the need for long-distance quick transfer of intelligence at uniform and low rates. Thus orders for goods, news of free-land operations, prices of commodities up or down, as well as reports of salesmen's dealings and whereabouts could for the first time be quickly passed from point to point at uniform rates.

Transmission Improvement

Over the years, transmission methods and service improved as mechanization of operations progressed. By the early 1920's telegraph operation by the original single wire, ground-return method had reached its peak, the multiplex and simplex printers fulfilling Morse's original dream of printing telegraphy. Increased demand for international communications following World War I had prompted further improvement in ocean cable facilities across the Atlantic. Using hitherto untried but technically sound principles and aided by advances in metallurgy, a continuously loaded submarine cable was designed and laid. It exceeded the best expectations of our engineers in the matter of speed, capacity and dependability. Operating at 400 words a minute the cable was faster "than two women gabbing over the back fence". Vacuum tubes and signal-shaping amplifiers, developed for the new cable, provided increased speed for the older cables as well, some of which dated back almost to the Field original. We had a good system, both landline and cable, and we were making progress.

No business can afford to be static, as the harnessmaker and the carriage-builder found out. The products of invention keep up a continuous change so that the situation is like that of Alice in the White Queen's land, where only by running very fast can you even stay in the same place. Western Union found out in the 1930's that we had to run still faster. Other advances in the communication art



Hirman Sibley, who organized construction of the transcontinental telegraph line along the pony express route, and backed a proposed overland pole line New York and Paris by way of Alaska and Russia.

Norvin Green, who became the first president of the AIEE. He was associated with the New Orleans and Ohio Telegraph Co.

were catching up. Air mail, heavily subsidized by the government, toll telephone and teletypewriter exchange service were offering ever-increasing competition.

During the busy World War II years we made plans and, when men and materials became available, the new look planned in the Western Union system began to take shape. We had in mind a system where only two operators would be needed, one to send and one to receive the telegram, instead of the old system in which messages were handled between distant points with intervening manual relays, with as many as five people handling the message at each relay point. With our new system, all of the routing and relaying could be handled by electronics or by high speed switching machinery.

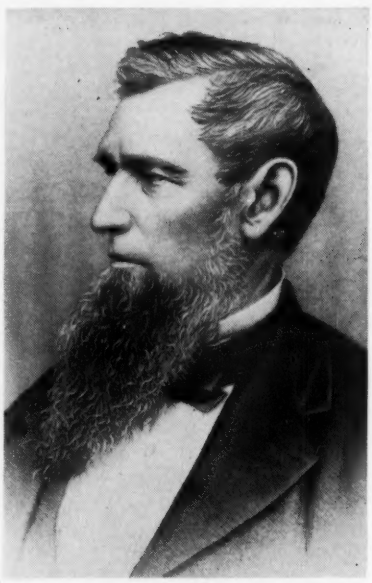
Today we are very close to that objective. Our 15 modern high speed message centers at strategic locations about the United States receive originating telegrams from their respective areas and, by automatic switching, transmit the messages on to the area center of destination practically instantaneously. At the receiving end, manual operation of a push-button switchboard with over 200 destinations narrows down the receiving office to the nearest branch, the addressee's direct wire connection, or other delivery media. The telegram appears only twice as writing on a sheet of paper; once when it is received from the customer and again when it is readied for final delivery. The rest of the time the telegram appears in the form of paper tape, punched with holes which represent the stored intelligence in telegraph printer code.

While this highly mechanized system was being installed, transmission methods between offices were being improved. Instead of the direct-current magnetically operated lines and repeaters, most telegraph signals now are transmitted electronically over a frequency-modulated carrier—twenty chanels are fitted into the spectrum required for a telephone or voice conversation and each separate channel delivers its own message to its own destination. These voice-bands can be obtained in groups by carrier methods over wires, cables, or microwave radio circuits. This apparatus and equipment is so efficient in operation, so fast and so accurate that Western Union is now handling over two-thirds of all rapid record communications.

Old Cables are rejuvenated

Nor have the ocean cables been neglected in our continued improvements. An innovation rendering the older cables suitable for modern high speed service consists of a submerged electronic amplifier, placed in series with the cable on the ocean bottom about 150 miles out to sea. This repeater, powered from the shore end, intercepts the received signal in the quiet deep water and boosts it before it has had a chance to become too weak to overcome the noise it will pick up in its travel through shallow water to shore. This provides a clear, strong signal and enables us to triple the speed or word-volume capacity of the cable. Thus, with the expenditure of a sum small in comparison to the cost of several million dollars required to lay a new cable, we can rejuvenate an old slow one, making it capable of handling signals at modern speeds. In fact, some of the rehabilitated cables are expected to approach the speed of the most modern cables.

While improvements in the printing telegraph system continue, we



Ezra Cornell, who aided in the construction and financing of the Baltimore-Washington-New York telegraph line.

are making truly phenomenal progress in "Telefax" or facsimile method of transmission. As a "record" communication company, we propose to accommodate records of any kind, anywhere, without reducing them to arbitrary telegraph codes which will print only in our English alphabet and require letter by letter hand typing. Facsimile will reproduce anything in black and white, manuscript or line drawings, using our proprietary dry recording paper, "Teledeltos".

We have used the "Telefax" to great advantage in telegram pick-up and delivery service to thousands of business houses in many cities, and thousands more are being installed now. Referred to humorously as "the electric messenger boy", our "Desk-Fax" transceivers, no larger than a portable typewriter, are used in thousands of business offices today all over the country. They provide what can be termed picture reproduction of telegrams from the customer to Western Union, and vice-versa, with easy facility. These little devices are so simple to operate that, as our president Mr. Marshall remarked, "Even the boss can work it."

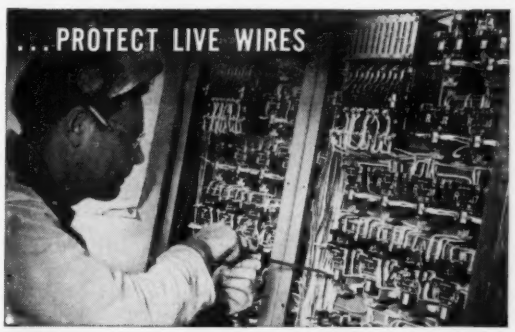
Still under development but already in restricted traffic service, we have the "High Speed Fax". This facsimile equipment can re-

(Continued on page 32)

HOW HERCULES HELPS...

MUSCLE FOR MOUNTAIN MOVERS—
More than 1,000,000 lbs. of Hercules® dynamite were used by S. A. Healy Co., Chicago, to hollow out a mountain near Washington, D. C., in the construction of an alternate global communications center for use in case present Army, Navy, and Air Force facilities are knocked out by enemy attack. The task of carving this top-secret headquarters out of solid rock would have been impossible without industrial explosives and excavating know-how.

Most businesses are helped today by Hercules' business . . . the production of synthetic resins, cellulose products, chemical cotton, terpene chemicals, rosin and rosin derivatives, chlorinated products, and many other chemical processing materials—as well as explosives. Through close cooperative research with its customers, Hercules has helped improve the processing or performance of many industrial and consumer products.



SHORT CIRCUITS STYMIED—
Complicated electrical installations give longer, more dependable service when vinyl wire insulation is made with Hercules Hercoflex® 150. Hercoflex 150 is one of the Hercules family of vinyl plasticizers that are used in products ranging from toys to garden hose.

EASY TO HANDLE —
These kitchen utensils not only make a woman's job easier, but their brightly colored handles add a decorative touch as well. The handles are molded with Hercules Hercocel® cellulose acetate. In sales, design, and production, Hercules' services to the plastics industry keep products on the move.

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Cornell Aeronautical Laboratory - -

Complex airflow at hypersonic speeds, a shock-absorbing collapsible steering column for automobiles, disposition of ships in a task force, and rocket control using jet vanes are examples of the varied research and development activities of the Cornell Aeronautical Laboratory, Inc.

Located in Buffalo, N. Y., the Laboratory is a self-supporting corporation with stock owned entirely by Cornell University. It employs 1000 workers and has a backlog of over 11 million dollars in research contracts. In addition to these expenditures by the armed forces and industry, the Cornell Aeronautical Laboratory last year invested over 100,000 dollars in internal research for ultimate public benefit.

Since the Laboratory's beginning in 1946, its history has been marked by constant growth and expansion. The Curtiss-Wright Corporation, in order to centralize its facilities in Columbus, Ohio, gave the original laboratory to Cornell University. Eight aircraft companies provided an initial donation of 650,000 dollars for working capital. Total yearly contract values have increased annually, from 3.5 million dollars in 1950 to 4.5 million in 1951, 7.35 million in 1952, more than 9 million dollars in 1953, and over 10 million dollars last year. The size of the Laboratory has tripled since 1946, and its equipment is valued at over 6 million dollars. Presently under construction is a 98,000 square foot addition and new building, part of a $1,250,000 program. It will place all departments except Flight Research, which needs access to airport runways, under one roof.

More than 90% of the Laboratory's research activities are in the field of aeronautics. The Aerodynamic Research Department has conducted investigations of low-aspect-ratio wings and wing-body combinations, with recent discoveries in this field leading to methods for determining spanwise as well as chordwise lift-distribution. This Department has studied heat transfer, boundary layer, and jet-mixing problems occuring at supersonic speeds. Results indicate that internal conduction by an airfoil is important in determining temperature and heat-transfer characteristics. The Aerodynamic Research Department has investigater methods of static-pressure measurement for subsonic airplanes, instability in aircraft ducting systems, pulsejet operation, unsteady flow analysis, and combustion and flame characteristics.

An 8½-foot by 12-foot variable density wind tunnel is the Laboratory's major experimental research tool for studies of subsonic airspeed problems. Special techniques have been developed to analyze separation-trajectories of objects jettisoned from airplanes in flight. Models of dropable bombs for use in the tunnel promise future progress in studies of ejection seats, cockpit canopies, and wing fuel-tank separations. Propeller research at supersonic tip speeds is conducted in the wind tunnel, involving evaluation of complete spinner and cowling installations.

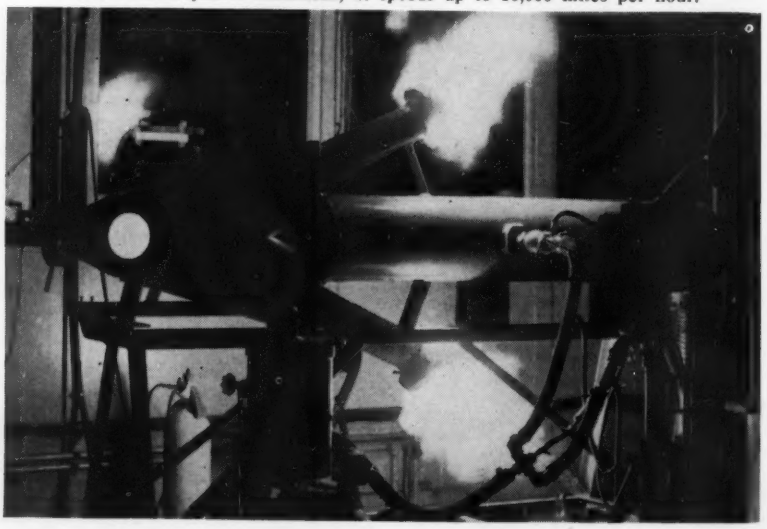
Operated within and utilizing the power equipment of the variable density tunnel is a special four-foot throat section designed for transonic speed research,. Speeds ranging from 600 to 900 miles per hour are attainable. One of the most efficient in the nation, this perforated throat transonic wind tunnel is unique in its effectiveness in alleviating the effects of shocks reflected back on to the model from the tunnel wall. This problem of shock is one of the most harassing confronting the designer of transonic tunnels.

Wind tunnel experiments

Cornell Aeronautical Laboratory also operates a hypersonic wind tunnel, in which the 10,000 mile-per-hour airstream glows at a temperature of 7000 degrees F. as it strikes a wedge-shaped test object. The tunnel utilizes a combustion tube in which a helium-hydrogen mixture is exploded. The ignited gases generate a shock wave as they burst a restraining diaphragm. The smooth flow following the shock wave is used for test purposes. The shock tube and test section are maintained at low pressure. Test speed is obtained by expanding the airflow through two supersonic nozzles, this expansion lowering the airflow temperature to minus 68 degrees F. in the test throat.

Cornell Aeronautical Laboratory has recently announced the con-

The hypersonic impulse tunnel developed at C.A.L. can perform tests on models, under stratospheric conditions, at speeds up to 10,000 miles per hour.



struction of a new transonic-supersonic wind tunnel capable of speeds from eight-tenths to three times that of sound. The new tunnel, valued at more than 150,000 dollars, will have a one-square-foot testing area. The twenty-ton tunnel shell will be housed in a new building. To reduce construction costs, the Laboratory applied engineering ingenuity to incorporate a pair of submarine motors, a compressor section of a jet engine, and surplus Navy power-transmission cable in the tunnel installation.

The Aero-Mechanics Department has tackled the problems of aero-elasticity and flutter of airfoils and control surfaces since the Cornell Aeronautical Laboratory began. In 1953, the Department completed a study of complex vibration and aerodynamic problems created by tip pods on straight and swept wings. Research into flutter-creating forces on low-aspect-ratio wings filled a gap in aeronautical knowledge by providing data on the aerodynamic characteristics of this increasingly-used wing form. The Aero-Mechanics Department includes a Structural Laboratory Section that ran structural tests on the first atomic bomb and their bomb releases. This department's Aircraft Equipment Branch has developed air-conditioning systems, missile-control devices, servo valves, and ramjet fuel controls. Other department divisions include the Electrical Laboratory Section and the Helicopter Research Section. In addition to various special projects, the Department conducts flutter analyses, static and dynamic tests, and guidance control system research for guided missile projects.

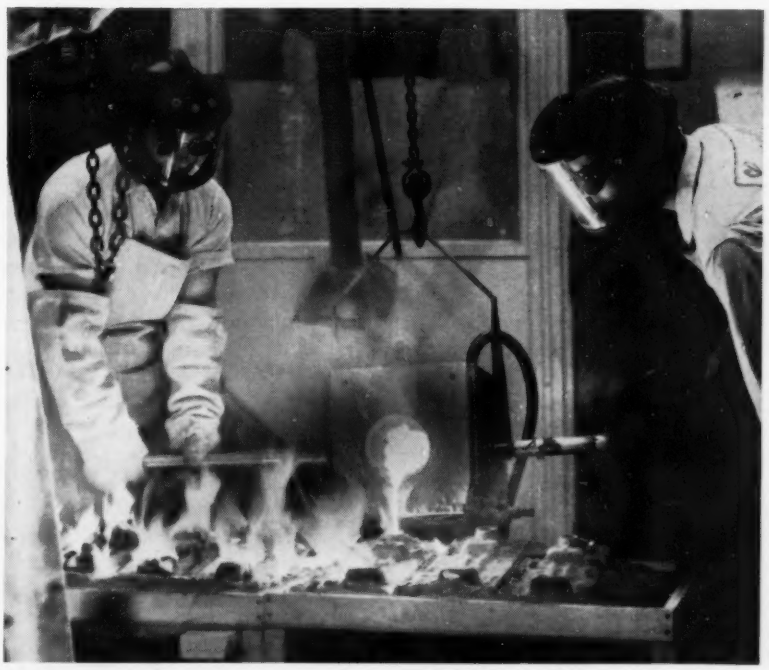
One airplane that acts as many, in effect changing the length and width of its wings, fuselage and tail as it flies, is a development of the Laboratory's Flight Research Department. Simulating these changes in the aircraft's geometry by electronic and hydraulic equipment, the system enables the pilot to vary the aerodynamic and control characteristics of the plane in flight merely by changing dial settings in the cockpit. An aircraft so equipped is an invaluable aid in research to determine ideal handling characteristics of aircraft, and the equipment has foreseeable application in such specific problems as improving bomber stability.

A B-26 bomber and an F-94 jet fighter have been adopted to a variable control system to determine the best handling characteristics for military aircraft. Artificial stability experiments include a damper for stabilizing high-altitude jet flight, and a modified C-54 transport, whose tendencies to oscillate and diverge from course have been replaced by rapid subsistences in rolling, yawing, and pitching. Other activities of the Flight Research Department include flights involving fully automatic controlled glides, studies of structural tail loading, and analyses of atmospheric turbulence. The Laboratory uses fifteen military airplanes for actual flight tests with a variety of aircraft types.

High-speed flight presents an accompanying problem of high temperature and its effect upon airplane skins and turbojet components. The Materials Department at Cornell Aeronautical Laboratory has evaluated present commercial metal alloys and has developed new alloys for use at temperatures up to 1500 degrees F. The Department's goal is to obtain alloys of low-strategic material content, or with minimum amounts of chromium, nickel, and cobalt. Testing devices, such as a model-type analog for measuring heat flow paths, are designed by the Department to meet specific project needs. Titanium has received special attention in order to determine its properties as a practical aircraft metal. A whirling-arm test apparatus is operated under a simulated one-inch-an-hour rainfall at a speed of 500 miles per hour, enabling rain erosion effects on plastic and metal materials used on aircraft wing leading edges to be gaged. Uses of foamed plastic for sandwich-type radar domes, methods of dome fabrication, and types

Workshop for the Future

by RICHARD BRANDENBURG, E.P. '8

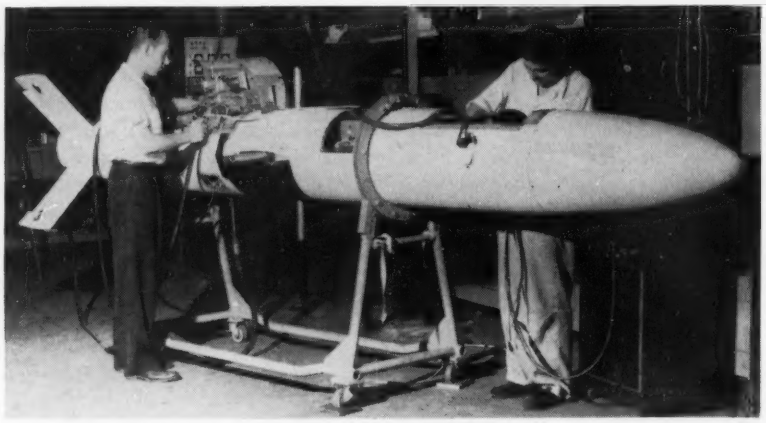


A metallurgy team at C.A.L. pours molten stainless steel into molds for forming test bars.

of bonding adhesives have been investigated by the Materials Department. In addition, studies have been made of the compatibility of rocket fuel combinations, and soil-stabilization techniques for airfield construction.

Physics Department

The Laboratory's Physics Department has undertaken such problems as the development of a true-air-temperature measuring device, investigation of atmospheric electricity, and a study of the earth's electric field. The Department employs about 45% physicists, and 35% electrical engineers. The staff has designed electronic equipment to maintain a zero-electrostatic charge on airplanes in the presence of severe electrical storms, automatic missile controls, traffic control computers, and autopilots. It has undertaken projects on radar and electronic systems for all-weather flying and has studied problems of aerodynamic measurement in flight and wind tunnels requiring precision physical instrumentation.



Guided missile research remains C.A.L.'s largest single effort.

The mangled metal and serious injuries of auto crashes have been subjected to detailed analysis in terms of physics and engineering by the Industrial Division of Cornell Aeronautical Laboratory. The Division has investigated the exact nature of body injuries by using accurately proportioned dummies during test runs in actual automobiles. Measurements of velocity and location of dummy impacts with car interiors in simulated crashes provide valuable data in redesigning automobiles for improved safety. Tests involving the use of safety belts and steering wheel chest pads have been made, and investigations of suspension systems, collapsible steering columns, and low-sway tires have revealed methods for improvement of auto handling. The Laboratory's versatility is apparent in the Industrial Division's work on the design of an agitator for blood after its removal and collection from the donor, a polio respirator jacket, protective aviation and football headgear, tractor seats with improved riding qualities, and energy-absorbing recoil pads for firearms. The Industrial Division extends a helping hand to industry by providing equipment, such as its High Altitude Chamber for product testing, and finding the solutions to specific problems of individual research sponsors.

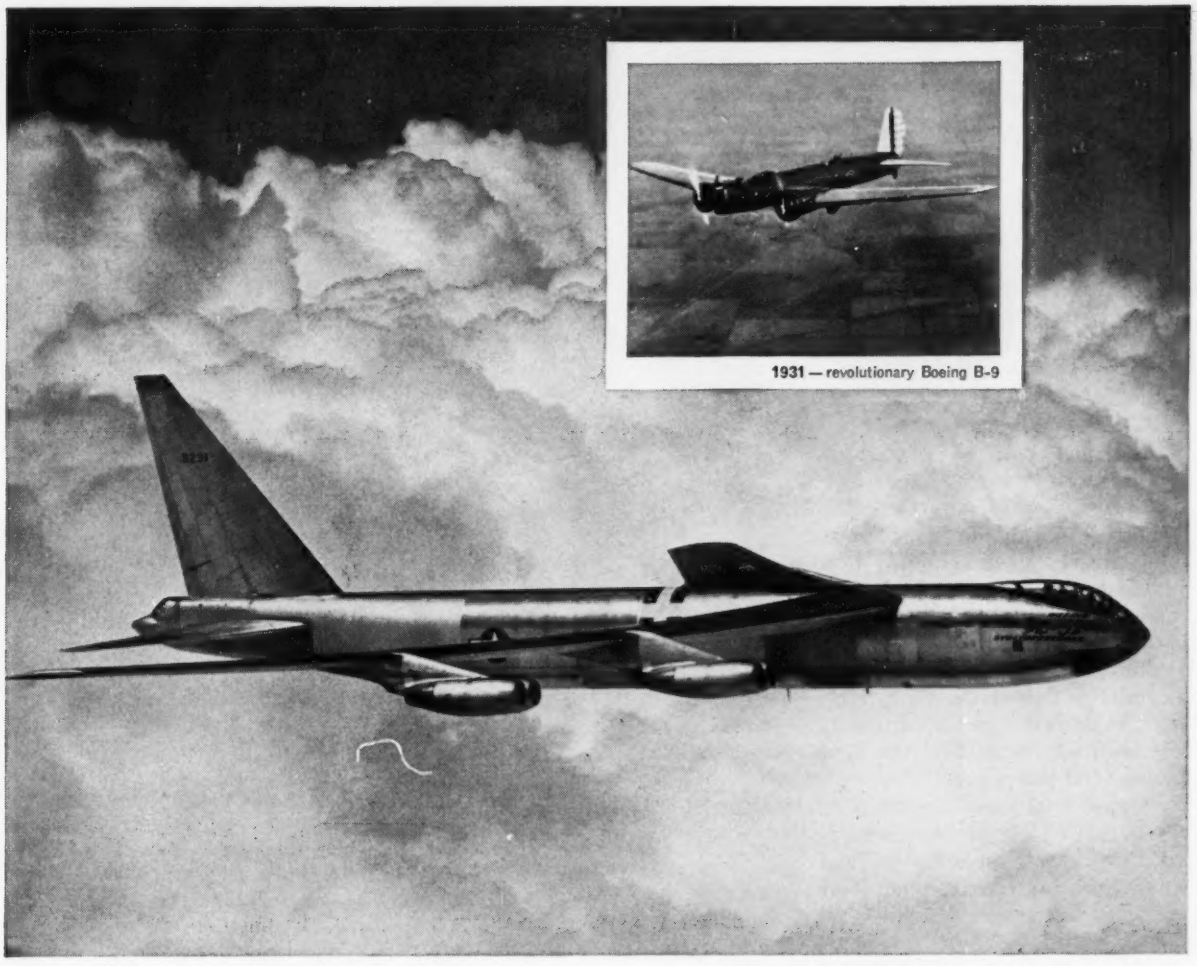
The most effective air defense for a Navy task force is typical of the studies made by the Special Projects Department of Cornell Aeronautical Laboratory. Mathematical models, electronic computers, and probability theory are combined to evaluate fighter-usage, air-to-air missile effectiveness, and the disposition of ships. Similar analytical methods have been applied to tactical air missions. Factors of speed, endurance, distance, and military load are weighed to determine proper selection of an airplane for a specific job. Missiles systems are studied in terms of cost in relation to range, payload, accuracy, and production rate. Classified studies of the design of missile launchers and the solution of missile-launching problems are being conducted, along with the evaluation of missile guidance systems. Consideration of the human factor in developing machines designed to minimize operational errors is an important phase of the Special Projects Divisions missile activities. Commercial air safety problems have been investigated, involving blind instrument landings, and utilizing the techniques of systems analysis.

Staff Contributions

Rounding out the varied activities of the Cornell Aeronautical Laboratory are the additional contributions to science and engineering made by individual staff members. Employees have participated in the Advisory Group for Aeronautical Research and Development (AGARD) of the North Atlantic Treaty Organization. The Laboratory's former Director is chairman of the Technical Advisory Panel for Aeronautics to the Department of Defense. Staff members have been active on air safety committees and in over a hundred professional and technical societies. The staff publishes a variety of articles and papers each year, and uses the facilities of the Laboratory's own Illustrations Group in preparing layouts and drawings for publication of reports.

Because it realizes the value of an educational role as well as achievement in industrial research, Cornell Aeronautical Laboratory supports eight graduate student fellowships at Cornell University. Individual stipends of 1500 dollars per academic year, plus tuition and fees are paid through earnings from research. An annual summer student-employment program gives almost fifty students an opportunity to gain practical engineering and research experience. Monthly seminars are held to give personnel an opportunity to exchange ideas and learn the overall scope of Laboratory functions. A program of partial refunding of tuition encourages many staff members to take additional graduate and under-graduate courses at the University of Buffalo. In addition, two staff members a year may take advantage of

(Continued on page 50)



1931 — revolutionary Boeing B-9

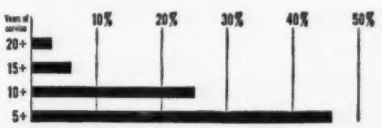
1954 — Boeing 8-jet B-52, America's outstanding heavy jet bomber

Leadership is a long-time tradition at Boeing

In 1931, Boeing engineers designed the B-9, a revolutionary low-wing bomber that could outdistance any contemporary pursuit plane.

Today, they've produced the free world's outstanding heavy jet bomber, the B-52, and America's first jet transport. Boeing also builds the record-breaking B-47 medium jet bomber, conducts a major guided missile program, and research in nuclear power for aircraft.

These growing programs mean expanding opportunities at Boeing for engineers of virtually EVERY type, including mechanical, civil, electrical and aeronautical. It also means plenty of room for advancement. Boeing, which now employs more engineers than even at the peak of World War II, promotes from within, and holds regular merit reviews to give you individual recognition.



As the chart shows, 46% of Boeing's engineers have been here for five years or more; 25% for 10 years; and 6% for 15 years, and many have been with the company 25 years or longer.

Boeing offers engineers an unusual variety of experience, from applied research to production design, from work with new materials and techniques to co-ordination of a vast subcontracting program which provides contacts with a cross-section of U. S. industry.

Boeing also helps engineers continue their graduate studies, and reimburses them for tuition expenses.

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Shell Molding

by STUART BRAUN, M.E. '57

Shell molding, or the "C" process of casting, is now emerging as an accepted and vital part of the foundry industry. Developed in Germany in 1944, the new method is now widely employed in both Britain and America. Basically, it utilizes a thermosetting resin, or plastic, as a sand binder to form durable and permeable shells into which molten metal is poured.

Initially, a mixture of fine sand and resin is applied uniformly to a heated pattern plate in the following manner: the plate is clamped to a dump-box which contains the mixture, the box is inverted and the mixture falls on the plate, forming a thin crust over the pattern as the resin softens to bind the sand grains. The box is then reinverted, the excess resin sand mix falling to the bottom. The soft crust is hardened by curing in an oven and finally stripped from the plate. This hardened crust forms a half-shell which, when aligned with an identical or complementary half-shell formed by a repetition of the cycle, constitutes a complete mold. The half-shells, with cores, are next assembled and clamped together, and the assembly is placed in a flask and backed up with a suitable bedding material which prevents distortion of the shell during pouring.

Any metal now cast in conventional green-sand molds may be cast in shell molds; however, only a limited number of materials have been cast in this manner, chiefly because the process is still in its infancy. Among the metals poured in the new molds are aluminum, brass, bronze, stainless steel, titanium, and certain ferrous alloys. To date, Ford has invested over $8 million in research developing the process for automotive applications. Large scale production of automobile and aircraft parts and equipment, farm machinery and other products is now in progress. It has been estimated that inside of ten years, shell molding will comprise half of all foundry casting procedures.

—Durez Plastic Co.

Fig. 1. The cope and drag halves of a shell mold are shown on the right along with the pattern plate and ejector pins, upper left, and the resultant casting.

The advantages of shell molding over green-sand casting are numerous:

(1) Excellent surface finish and detail in the end product are attainable.

(2) A high degree of dimensional accuracy places it between sand-casting and investment casting in this respect. Tolerances of from .001-.003 are easily attainable.

(3) Thin sections are easily reproduced.

(4) More castings are produced per ton of metal poured.

(5) A higher production per man-hour per square foot of floor space.

(6) A greatly reduced sand: casting weight ratio; up to ten times as much sand is used per casting in a green sand mold.

(7) The use of less sand makes for cleaner working conditions.

(8) Lightweight molds facilitate transportation to any part of the foundry.

(9) Elimination or dimunition of machining operations through dimensional accuracy and excellent surface finish.

(10) A low reject rate is made possible by mold porosity and freedom from shrinkage during cooling of the resultant casting.

(11) A high degree of mechanization is easily applicable to the process. Shell-making machines are completely automatic while the lightweight shells are mechanically transported.

(12) The use of skilled labor is completely eliminated by mechization.

(13) Shells can be stored indefinitely to provide a backlog for production.

Investment Mixing

The first operation of the process consists of investment mixing, that is, blending the resin and sand to produce a sound shell. Very fine, washed silica sands are utilized, with a clay content under 3 per cent, and a minimum of metallic oxides and

fluxing agents. Generally, the finer the sand, the smoother the surface finish; however, sand fineness must be sacrificed for mold permeability. Additives such as silica or zircon sand are employed to improve surface finish.

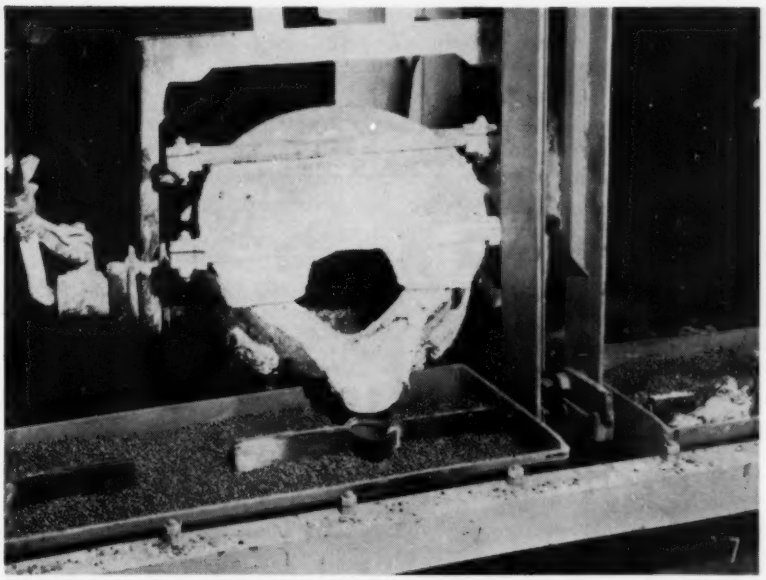
The resin binder employed most extensively is a two-stage phenolic-formalhyde resin, formed by the condensation reaction of phenol and formaldehyde at high temperatures. The two components are heated in a steel reaction kettle with an acid catalyst to form a linear high polymer, an organic compound with a two-dimensional molecular chain structure. At the completion of the first stage, more formaldehyde is added in the form of hexamethylene tetramine, a white crystalline solid which decomposes to formaldehyde and ammonia, which acts as a catalyst for the second stage of the reaction. The resulting phenol-formaldehyde resin has a three dimensional molecular structure with cross linkages among the linear chains.

The resin content of the investment mixture ranges from 5-9 per cent. by weight of the sand used; surface finish of the shell varies little with differing resin contents, but tensile strength and compression strength of the resultant shell increase with increasing binder content.

The mixing operation may be of two types: dry blending and hot coating. In both methods it is essential to insure uniform dispersal of the binder throughout the sand; each grain must be thoroughly coated. In dry blending, the two components are mixed in a sand muller heated to a temperature low enough to prevent resin flow. The hot coating operation is preferred to dry blending as it applies a more uniform resin coat to all particles in the system. Sand and a liquid 2-stage resin are fed into a high-speed muller under the simultaneous application of heat by a hot air steam blown into the muller. The resin condenses and then soldifies into a lumpy mix which is then cooled and subjected to break-up to the original particle size.

Shell Forming

Subsequent to the mixing operation, the shell-forming process proceeds as the above mixture is applied to the heated pattern plate for from 6 to 15 seconds. During this application the resin progresses from a state of extreme flidity to substantial viscosity and finally hardens to bind the sand grains into a soft shell, usually about 3/16-1/4-inch thick.



—*Durez Plastic Co.*

Fig. 2. Assembled shell mold backed-up metal shot is about to be poured.

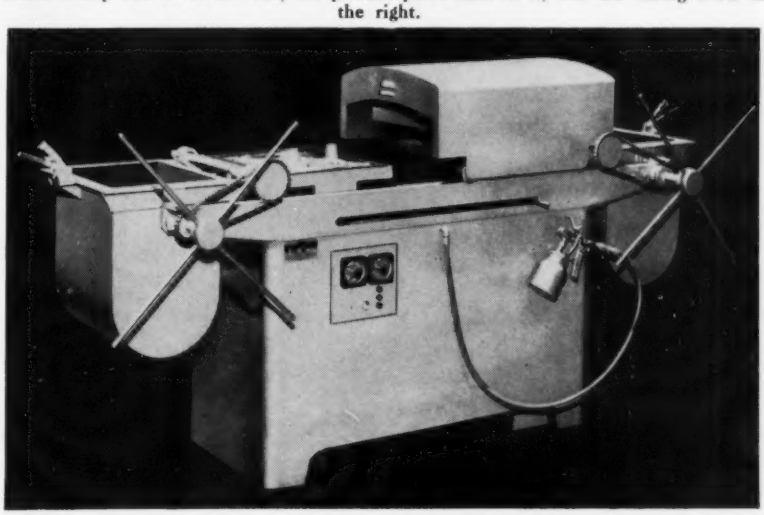
Preheating and Releasing Agent

Before contact with the resin-sand mix, the pattern plate is preheated to a temperature of 250-500° F, depending on design and thickness of the plate and the type of resin used. Prior to the shell forming, a release agent is applied to the pattern plate to prevent sticking of the shell during stripping. A silicone water emulsion has been found most satisfactory, but other release agents such as paraffin wax and silicone oils and greases have yielded good results. Considerations involving use of these substances include: (1) chemical inertness of the agent at the high temperatures of the pattern plate (2) amount and method of application (3) cleanliness of pattern surface after stripping, and (4) sharpness of mold edge and mold smoothness.

Pattern Equipment

The pattern plate is the lifeline of the "C" process and represents

Fig. 3. Single-stage shell mold machine manufactured by Shalco Corp., Palo Alta, California. Dump box is on the left, the pattern plate next to it, and the curing oven on the right.



a great initial cost to the foundryman. These patterns must be precision-manufactured to tolerances of .0015-.0020 inches in order to assure the high dimensional accuracy of the finished product. Pattern plate materials used to date include alloy cast-iron, "non-shrink" steels, aluminum, and other heat treatable alloys. They must withstand thermal distortion and consequently possess high heat capacity and low-expansion characteristics. The plate should be at least ½-inch thick and able to retain sufficient heat during the molding cycle so that preheating may be reduced to a minimum. The general finish must be excellent, as the shell will record even the slightest imperfection. Drafts of ½ degree are incorporated in the pattern, as are the necessary risers and gates. Stripping and locating pins are an integral part of the pattern design while in some cases heating elements are provided to facilitate continuous heating during the cycle.

The problem of pattern plates is essentially one of theromdynamics. The heating and cooling cycles to which the plates are subjected make selection and fabrication of pattern material extremely difficult. Aluminum is a desirable material because of the weight factor and favorable machining characteristics.

Action of the Resin

As heat is transmitted to the resin after contact with the plate, it melts, while its viscosity falls sharply for a time. Simultaneously, the heat causes the resin condensation reaction to begin. A point is reached ultimately at which the condensation overcomes the thinning action, and the viscosity climbs sharply. It is found that a reduction in pattern temperature would lengthen the flow period, that is the duration of low viscosity. Since a minimum flow period is desired to shorten the molding cycle, a high temperature would be beneficial. But a compromise must be reached, since too high a temperature results in shell sticking and reduced shell strength.

A new shell forming process has been developed recently which promises to replace the dump-box method. Shell blowing is designed to produce shells with uniformly dense surfaces, an impossible accomplishment when the resin/sand mixture is forced into the mold cavities by gravity. Air pressure of about 30psi blows the mix onto the pattern behind which is a backup that heats the plate.

After investment and shell buildup, the shell is cured, that is altered from a soft to a hard crust. The pattern and shell are placed in an oven, and the resin is transformed from a fusible to a completely infusible product, into a hard, insoluble plastic. After curing, the shell is stripped from the plate by ejector pins. The curing temperature and duration are a function of shell thickness, pattern temperature, and resin content. A combination of pattern temperatures of from 350-500° F and oven temperatures of from 600-1000°F necessitate curing times of from 20 seconds to 2½ minutes.

Closing the Mold

To align and clamp two complementary mold halves for pouring, several methods have been utilized. Bolt holes may be incorporated in the shell to provide for bolting; "C" clamps, U-type speed clips, air pressure, air-drying adhesives, bonding tapes, pastes, and thermosetting liquid resins also serve this function. In some cases the backup material suffices to close the mold.

(Continued on page 48)

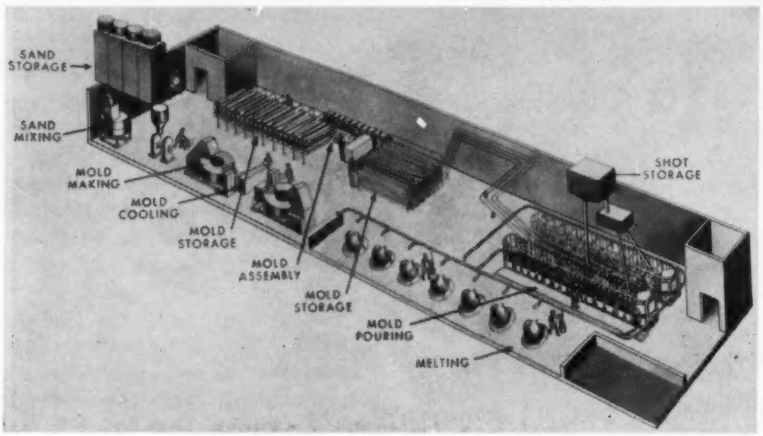
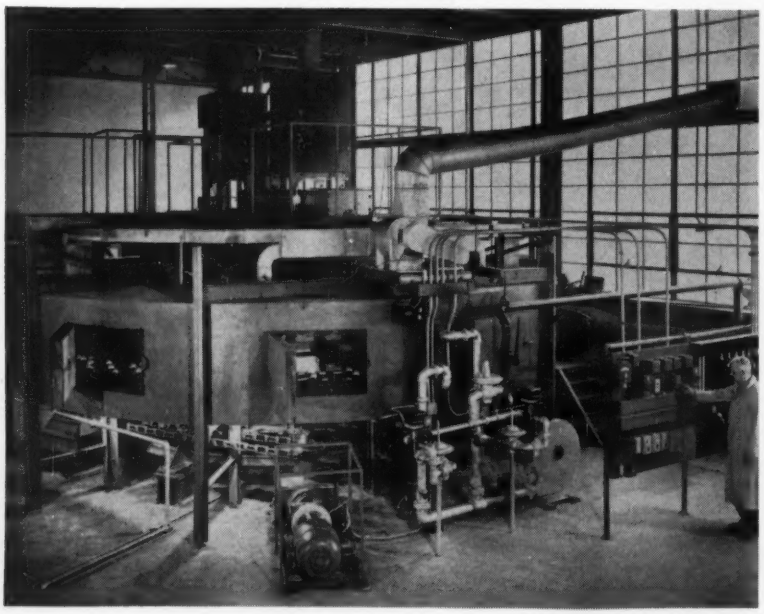
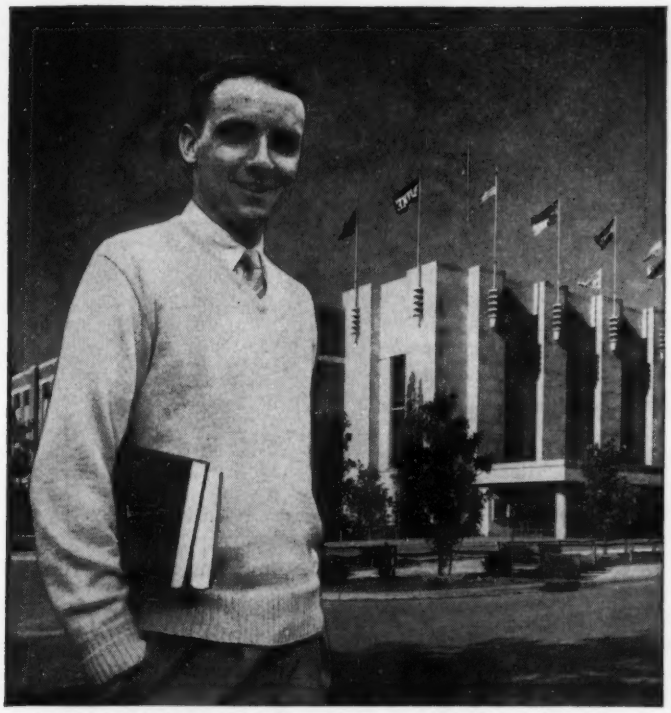


Fig. 4. Highly mechanized shell mold foundry of the Walworth Co., Boston.

Fig. 5. Multi-stage shell mold machine manufactured by Mechanical Handling System, Inc., Connellsville, Pa.





James B. Walker received his B.S. in mechanical engineering from North Carolina State College in June 1954, and he's presently working for his M.S. at the same college. By asking pertinent questions, Jim is making sure that the position he finally accepts will be the right one for a fellow with his training.

Jim Walker asks:

Can a mechanical engineer make real progress in a chemical firm?

H. M. Pickering, Jr., received a B.S. in M.E. and E.E. from the Univ. of Minn. in 1940. He gained valuable technical experience at Hanford Works, in Richland, Washington, and in Du Pont's Fabrics and Finishes Plant at Parlin, N. J. Today he is Works Engineer for Du Pont's Seaford, Del., plant, where nylon comes from.

"Pick" Pickering answers:

Well, Jim, that's what the lawyers call a leading question, and the answer leads right into my bailiwick. I came to Du Pont in 1940, after taking a combined mechanical and electrical engineering course. So I had what you might call a double reason for wondering about my future with a chemical firm.

I soon learned that the success of a large-scale chemical process is vitally dependent upon mechanical equipment. And the success of this mechanical equipment—especially for a new process—depends on (1) Research, (2) Development, (3) Plant Engineering, and (4) close Supervision. The net result is that a mechanical engineer at Du Pont can progress along any one of these four broad highways to a top-level position.

My own Du Pont experience includes mechanical engineering work in fields as varied as atomic energy, fabrics and finishes, and nylon manufacture. Every one of these brought with it a new set of challenging problems in construction, instrumentation, and power supply; and every one provided the sort of opportunities a man gets in a pioneering industry.

So, to answer your question, Jim, a mechanical engineer certainly has plenty of chances to get somewhere with a chemical company like Du Pont!

Want to know more about working with Du Pont? Send for a free copy of "Mechanical Engineers at Du Pont." This 24-page booklet describes in detail the four broad categories of jobs mentioned by "Pick" Pickering. Typical pioneering problems in each of these four categories are outlined. This booklet briefs a young mechanical engineer on how some of the newest and most challenging problems in his field were solved. Write to E. I. du Pont de Nemours & Co. (Inc.), 2521 Nemours Bldg., Wilmington, Del.

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FACULTY PROFILE

The spurting geysers, slipping ladders, swinging pendulums, and emphasis on "F equals MA" that highlight lectures in Freshman Physics 115-116 will be used for the last times this year by Professor Guy E. Grantham. He plans to retire, marking the completion of a forty-four year teaching career. Professor Grantham, called "Granny" by his friends and associates, is a native Hoosier who earned his Bachelor's and Master's degrees at Indiana University. He gained his first teaching experience as a physics instructor at Purdue University.

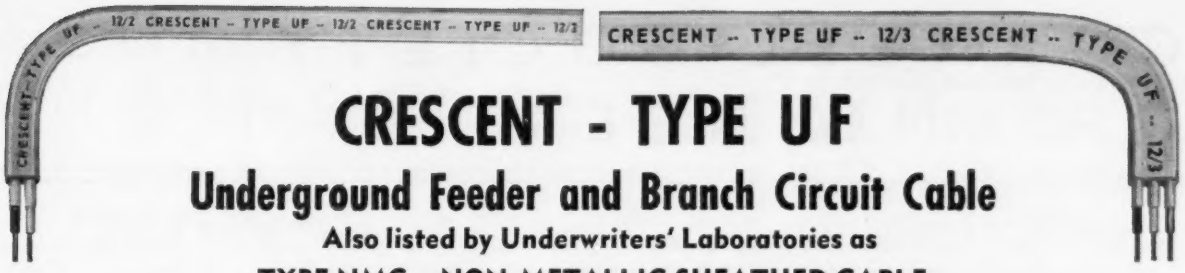
Professor Grantham came to Cornell on a President White Fellowship in 1915. After serving in France in the army as a Signal Corps Captain, he returned to Cornell to become a physics instructor and to work on his Doctor's degree. Professor Grantham moved to Texas A&M as an associate physics professor for a year and then spent seven years teaching electrical engineering and physics at the Post Graduate School of the United States Naval Academy. Returning to Cornell University in 1928, Professor Grantham rose from Assistant Professor of Physics to Professor in 1936 and Professor of Physics and Engineering Physics in 1947. He was appointed as executive officer of the Physics Department in 1950.

Professor Grantham believes he would rather teach than do anything else. His lectures and class instruction reflect an intense enthusiasm that is epitomised in his assertion that he likes teaching physics so much that he would gladly, if independently wealthy, "pay the University to be able to do it." Always on the lookout for new methods to help freshmen grasp basic physical principles, Professor Grantham has introduced new techniques in his physics lectures. Though he is credited with first using television in the lecture room to display microscopic phenomona, Professor Grantham is quick to point out that he got the idea from an RCA demonstration. His outline of potential television uses in physics instruction stimulated an RCA loan of cameras and receivers to the University.

Prof. Guy E. Grantham

"My main job is to see that courses run smoothly," says Professor Grantham when he refers to his attempts to integrate physics with the overall engineering curriculum. He emphasises fairness in administrating Physics 115-116. Each prelim given in the courses must first have the approval of all instructors, in order that any question may be changed that is unduly difficult. Professor Grantham believes that "Cornell engineers are fair, and they recognise fairness." This year he will carry a full teaching load, including three recitation sections, a weekly lecture, and work as advisor for a class of Engineering Physics students.

As one of the planners of the Engineering Physics curriculum at Cornell when it began six years ago, Professor Grantham was on the committee to establish the new school. The committee determined from industrial leaders just what type of course should be offered in order that graduating students could obtain employment in industry. Professor Grantham be-



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lieves that the Engineering Physics course is the best five year training for a professional physicist today. He asserts that a graduate in Engineering Physics can assume a variety of positions in almost any field of engineering.

Professor Grantham advises freshmen that the most important factor in mastering physics is to get started immediately at the beginning of the term. He points out that college physics is not like high school work and that "if a freshman is planning to loaf in the course, he should do so the last two weeks of the term." In analyzing the results of Scholastic Aptitude Tests, Professor Grantham finds there is little correlation between high math grades on the tests and success in physics, while there is definite relationship between verbal scores and good physics marks. He reminds Freshmen engineers not to underestimate the value of English courses and the ability to read and express themselves in writing during their college training.

Trying to help a freshman class is a joint affair, according to Professor Grantham. He hopes students realise they should exert less effort attempting to hide their ignorance from their teachers, and more in cooperating with them by indicating what they do not understand. In practicing this attitude, Professor Grantham says his office has always been open in order that any Freshman having difficulty with physics may obtain help.

Off campus, Professor Grantham is active in a variety of organizations. He has been a member of the Board of Trustees of the First Methodist Church as well as eight professional and honorary societies. These include Phi Beta Kappa, the Optical Society of America, the American Physical Society, the American Association of Physics Teachers, and the American Association for the Advancement of Science. In addition, he has participated in the Masons, Shriners, Rotarians, and local community chest campaigns. Professor Grantham, who lives in Cayuga Heights, met Mrs. Grantham while he taught at Purdue as a young physics instructor. His wife was a student in one of his classes. The Granthams have one married daughter.

Professor Grantham is the author of several publications on infra-red spectroscopy, the field in which he did research for his Doctor's degree. He is co-author of a general physics text and of several articles in physics periodicals. In addition, he has prepared the lab manuals for physics 115-116 for the last thirty years.

After completing his final year of teaching, Professor Grantham is not sure what his plans for retirement will be. He claims he has no "12 month" hobbies, is too impatient for fishing, and that the only thing he can paint is a barn. In a more serious vein, Professor Grantham indicates that he might apply for a fellowship, continuing work in physics after next June.

Professor Grantham's attitude toward teaching has been marked by a concern for students and a dedicated interest in helping Freshman Engineers learn physics. In looking back on his forty year career, he observes, "If I had to do it over again, I would do it exactly the same way."

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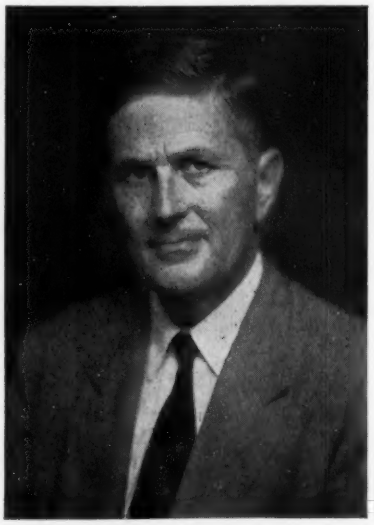

Walter M. Bacon

"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates, and former students and to establish closer relationship between the college and the alumni."

Specialization in Engineering

The inability of a single individual to absorb or even become more than remotely familiar with the amount of accumulated engineering knowledge existing today is resulting in a very definite trend toward specialization on the part of the technical student. This trend is to a certain degree inevitable and necessary. Not many years ago a single or at the most two branches of the engineering profession were being taught. These were civil engineering and mechanical engineering. Electrical engineering was then added and has been followed in turn by chemical engineering and engineering physics. Further specialization within these broad categories such as emphasis on power or communications in electrical engineering has been common for many years. Many engineering colleges have gone even further and are producing graduates quite highly skilled in very specific and narrow fields. There is a great demand for these highly specialized engineers in industry for engineering research, fundamental development and specific development jobs.

There is however an equally great need for less specialized engineers for operations and systems engineering work. These men must be capable of determining what is needed, directing and evaluating its development and putting together a system composed of the output of many specialists. They must have a thorough background in the basic sciences, general engineering knowledge and economics. They must be able to deal successfully with people and coordinate the efforts of many in widely divergent fields. They must understand the needs and capabilities of the people who are to use and work with the systems they create. They must be capable of original and creative thinking and be able to systematically analyze engineering problems. They must be effective in the oral and written presentation of the results of their engineering plans and studies. This type of engineer is also in great demand in the field of fundamental long range planning. He must be able to look ahead, anticipate future needs many years in advance and estimate the impact of improvements in the art and the effect of new basic technological tools that may at the present time be just emerging as a result of basic research.

The additional time made available by the five-year curriculum in engineering at your University provides you with an excellent opportunity to broaden the scope of your studies and make yourself a better candidate for a systems or operations engineering job. It also permits those of you whose interests are in a highly specialized field to gain additional knowledge in that field and therefore become preferred candidates for specialized jobs. Your extra year of study can mean a lot to you. Take advantage of the opportunities it offers.

M. W. BACON

ALUMNI ENGINEERS

W.R. Turnbull, M.E. '93, and Mrs. Turnbull, Rothesay, New Bruswick, Canada, received a cable from Buckingham Palace, London, May 31, conveying Queen Elizabeth's congratulations and good wishes on their sixtieth wedding anniversary. Turnbull built Canada's first wind tunnel, later experimented with aircraft propellers, and holds patents on an electric controlable-pitch propeller.

Wilton Bently, M.E. '98, retired in January, 1953, as executive vice-president of K. W. Battery Co. and is now acting as consultant to the company. His address is 14 Hastings House, Hastings-on-Hudson.

Clarence Seagrave, C.E. '11, spent a week end at his 25-acre farm at 585 Woburn St., Wilmington, Mass., the balance of the week as chief engineer for Corcoran Bros. Construction, Inc., a private firm. Four years prior to Sept., 1953, "being fortunate in retaining good health, I served as chief engineer for Air Installations of the Air Force Cambridge Research Laboratories of Cambridge and Bedford, Mass. I enjoy the work and anticipate several years more. For a little over 2 years, we've enjoyed the farm; don't do much but we find plenty to occupy us."

Robert W. Austin, C.E. '12, was given the George W. Fuller Award at the national meeting of The American Water Works Association held in Seattle, Wash. last May. This award is given annually to water supply engineers "for distinguished service, sound engineering skill, and construction leadership." Austin is a hydraulic engineer with the New York State Publice Service Commission. His address is 11 South Lake Avenue, Albany.

David H. Blakelock, 17, C.E. '23, writes that he "retired from the US Army, June 30, 1950, after thirty-four years of continuous service, with the rank of brigadier general, and settled in San Clemente, Cal. On retirement, I became interested in local government and was appointed to the City Planning Commission in 1951, was elected to the City Council in 1952, and was elected mayor in 1954 for a two-year term."

George W. Teare '22, B.Arch. '24, B.S. '31, and **H. Glenn Herb '31** select material for decorating the new Stouffer's Westgate, recently opened on US Route 20 on the west side of Celevland, Ohio. Teare, as architect and director of construction for The Stouffer Corp., is principally responsible for the "atmosphere" of Stouffer Restaurants in seven cities of the Middle West and East. He is in the corporation's general offices at 1375 Euclid Avenue, Cleveland 15. Herb, formerly manager of the Randolph Street Stouffer's in Chicago, now runs Stouffer's Westgate,

Clarence Seagrave and grand children

Center Ridge Road at West 210th Street, Cleveland.

W.M. Hepburn, M.E. '11, leading industrial furnace technologist, and pioneer designer and devolper of industrial heating equipment, last May receiver the Trinks Award, the nation's top honor for achievement in the industry.

A judges' panel of industrial heating authorities bestows the Award among candidates nominated by the industry on the basis of the most outstanding contributions to progress in that field. Mr. Hepburn was selected by the Award Committee for his outstanding research and development work in the industrial heating equipment field. During 40 years of service, many of his developments, including some 25 design patents, have proved notable milestones in the progress of the industrial gas furnace field.

A native of Freehold, N. J., Mr. Hepburn began his professional career as a junior engineer with United Gas Improvement Co. and four years later joined the Surface Combustion Corporation.

Chester W. Ludlow, M.E. '24, is a sales engineer and North Jersey representative for Philadelphia Gear Works, Inc., Philadelphia, Pa. He has a step-daughter, **Susan,** who was graduated from Cornell in '51. Ludlow is a member of the Cornell Clubs of New Jersey and New York.

Robert Volkening, M.E. '24, has been a partner in the brokerage firm of Burton, Cluett & Dana, 120 Broadway, New York City, since 1943. He lives at 252 Oak Ridge Avenue, Summit, N.J.

Clarence R. Carr, E.E. '29, 478 Hammond Street, Corning, is a mathematics teacher and boys' counselor at Corning Free Academy and a colonel in the Ordnance Corps, US Army Reserve. "On November 2," he writes, "I was made commandant of the 1052d ARASU, Elmira USAR School (Reinf.) . . . There are five schools assigned to me, a Judge Advocate General and Artillery School in Ithaca, a Medical School in Bath, and a Transportation & Command and General Staff College School in Elmira."

Myron R. Jones, C.E. '32, is a sales engineer with The Union Metal Manufacturing Co., Canton, Ohio, where he lives at 1927 Thirty-second Street. Jones is married and has one son, Frederick Ross, aged four.

Henry Gally, Jr., C.E. '34, has become associated in the Consulting Enginering practices of Frederick C. Woods '24, First National Bank Building, Greenwich, Conn.

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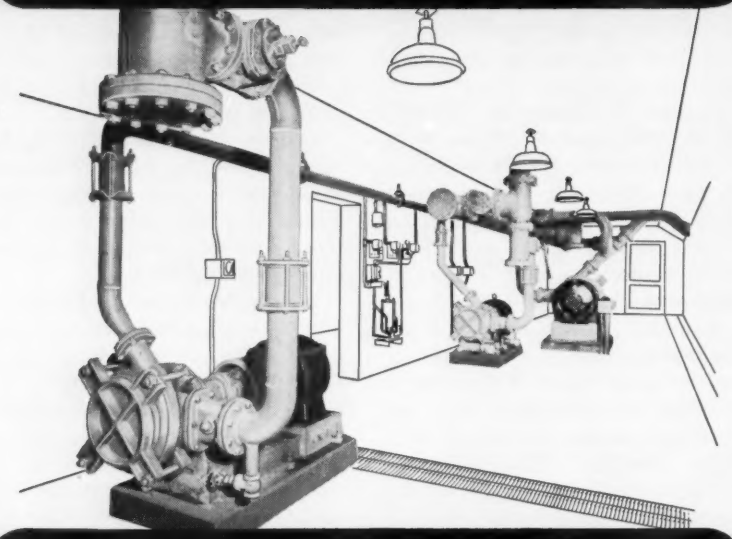

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A case in point is this Morris installation at the Missouri Portland Cement Co., St. Louis, Mo. The two Morris 3R Pumps in the foreground each handle 200 GPM of a cement slurry at 64% solids with 1.66 specific gravity. Speed is 1180 RPM. The 6R Pump in the background handles 600 GPM of the same slurry at 880 RPM.

Long operating life...
little or no maintenance

Massive running parts of the Type R compensate for the increased load imposed by high specific gravities. Hydraulic passages are deliberately designed for high concentrations of solids—the result of careful study of wear patterns shown by pumps in the field handling all kinds of abrasive materials. Elimination of areas of throttling and turbulence assures uniform wear of all parts.

There are no internal studs or bolts—no troublesome internal joints and fits. The suction disc liner is merely *clamped* into position between disc and shell. The absence of high stress on the shell permits wide variations in its composition—including materials of high abrasive resistance—to resist wear and extend the operating life of the pump.

Let our engineers consult with you on your slurry pump problems. They'll give you the benefit of 88 years of pump-building experience. Or, write for Bulletin 181.

MORRIS MACHINE WORKS
Baldwinsville, New York
Sales Offices in Principal Cities

MORRIS *Centrifugal Pumps*

Gally had for several years been a construction superintendent with the Turner Construction Co., and his background was ideally suited to the work that Woods was doing in developing economics in the construction of various types of buildings, such as public schools, university buildings, and warehouses.

National Advisory Committee for Aeronautics has announced the reappointment of **Robert B. Roe, E.E. '39,** to its subcommittee on helicopters. Roe is head of the flight operations engineering department of Sperry Gyroscope Co., Great Neck. His address is Box 571, Stony Brook.

Lawrence A. McNulty, M.E. '42, has moved from Los Angeles, Calif. to Baltimore, Md., where he is a design engineer with Westinghouse Electric Corp. His address is 537 Thornfield Road.

Norman M. Barrett, M.E. '42, writes, "I am still with Shell Oil

George W. Teare and H. Glenn Herb

Co. I was recently transferred from district engineer in Washington, D.C. to field engineer, Boston Division." He and Mrs. Barrett **(Caroline Gould) '44** have three children and live on Cole Road, Wayland, Mass.

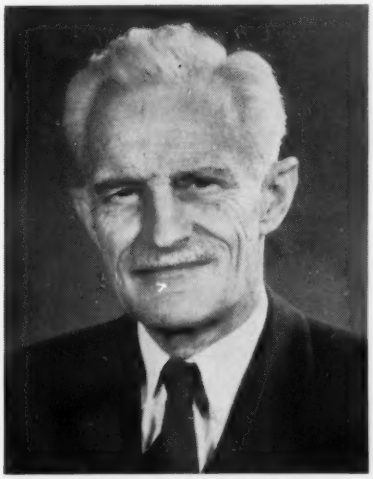
James R. Robinson, '42, M.E. '50, has sold his own drafting service to become chief draftsman for Beckman Instruments, Inc. He has two daughters, Linda ten and Karen six. His address is 1301 Maryknoll Avenue, Whittier, Calif.

Milton Stolaroff, E.E. '44, 4614 Northridge Drive, Los Angeles 43, Calif., is a manufacturers' representative in electrical and electronic

components. He writes, "After about 2½ years in wonderful Southern California, wife Barbara, daughter Linda (5), and I feel like old timers here, and love it. Our agency is becoming very well known locally and its progress is very gratifying."

Paul Alamar, M.E. '44, manages two flat glass fabrication plants (at Scranton, Pa. and Okmulgee, Okla.) for H. Perilstein Co. He lives in Scranton at 620 Colfax Avenue.

Edward S. Good, Jr., C.E. '47, 20-33 Seagirt Boulevard, Far Rockaway 91, is general superintendent for Woodcrest Construction Co., Inc., New York City. He has a daughter Judith Ann one-and-a-half, and a son Edward III.



William M. Hepburn

Robert J. Ratner, C.E. '48, writes, "My wife and I have just moved to Florida from California and I am employed as a highway engineer with Rader Engineering Co. of Miami, in charge of highway design on a section of the Florida Turnpike." Ratner's new address is 1500 SW Second Avenue, Miami, Fla.

Edward Sharafanowich, M.E. '48, and his wife are the parents of a son, Douglas Edward, born March 5. Sharafanowich is with Westinghouse Electric International Co., 40 Wall Street, New York City.

NECROLOGY

Francis Raymond, M.E. '92, April 17, 1954. He lived at Hotel Paul Revere, 2646 Park Avenue, Detroit 1, Mich.

Homer Cary Brown, C.E. '97, May 9, 1954, at his home, 750 North Eighty-first Street, Seattle, Wash. He was a retired rancher.

Frederick Bernhard Hufnagel, M.E. '00, Dingletown Road, Greenwich, Conn., May 16, 1954. He became president of Pittsburgh Crucible Steel Co. in 1920 and of the parent company, Crucible Steel Co. of America in 1926. In 1937, he became chairman of the board, holding all three offices until his retirement in 1944. Son, Frederick B. Hufnagel, Jr. '33. Kappa Sigma.

David Rader Thomas, M.E. '01, P.O. Box 575, Inverness, Fla., April 24, 1954. He was for many years president of Electric Railways Freight Co., Cleveland, Ohio. Brother, John R. Thomas '07. Delta Kappa Epsilon; Sphinx Head.

Harry Edwin Smith, M.E. '05, 531 Third Avenue West, Hendersonville, N.C., February 3, 1954. He has been an engineer with General Electric Co. in Schenectady for twenty-five years. He retired in 1947.

Carl William Lange, M.E. '05, in April, 1954. He retired in 1948 as an engineer in the meter engineering department of General Electric Co., Erie, Pa., where he lived at 443 Kahkwa Boulevard. He had been with the company for forty-one years.

Howard Lewis Aller, M.E. '06, 4509 Fairfax, Dallas, Tex., April 20, 1954. He was formerly manager and president of Central Arizona Light & Power Co. in Phoenix, supervising executive of Electric Bond & Share Co., New York City, and president and chairman of American Light & Power Co., New York City. In 1945, he became president of Texas Utilities Co. in Dallas and last year was elected chairman of the board. Theta Xi.

Carl Frederick Meyer, M.E. '08, 211 West Lanvale Street, Baltimore 17, Md., April 9, 1954. He was for many years a special agent with Income Foundation, Inc., Philadelphia, Pa. Brother, Richard C. Meyer '11.

Louis Burhans Daumont, M.E. '09, April 23, 1954. He lived at Blue Acres, Pemberton, N.J. Chi Psi.

Francis Sheridan O'Reilly, C.E. '09, Holmewood Inn, New Canaan, Conn., April 25, 1954. He was

PRODUCTS DESIGNED FOR STEEL COST LESS BECAUSE:

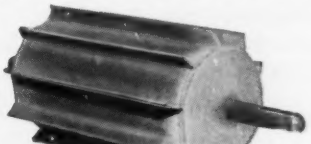
1. **Steel is 3 times stronger than gray iron.**
2. **Steel is 2½ times as rigid.**
3. **Steel costs a third as much per pound as cast iron.**

CUTS COSTS WITH WELDED STEEL

PRODUCTION costs largely determine whether a design is acceptable for manufacture. The successful designer therefore, seeks out every opportunity to eliminate unnecessary expense from his engineering recommendations.

Because steel is stronger, more rigid than iron, yet costs a third as much per pound, costs on many products such as the two shown below can be cut as much as 50%.

COSTS 30% LESS— Machine bracket is welded from 10 gauge metal. Weighs half of original cast design. Cut is stronger, more rigid. Costs 30% less to produce.



COSTS 45% LESS— Feeder roll is built from standard channel welded to steel discs. Steel design eliminates breakage, weighs half of former casting. Saves 45% on cost of manufacture.

Ideas for designing in welded steel

Bulletins and handbooks on latest design procedures are available to engineering students. Write:

THE LINCOLN ELECTRIC COMPANY
Cleveland 17, Ohio
THE WORLD'S LARGEST MANUFACTURER OF ARC WELDING EQUIPMENT

Telegraph

(Continued from page 16)

produce an entire letter-size page of writing or diagrams in half a minute. Two transmitters are used alternately, because the transmission is so fast, to permit one to be loaded while the other is transmitting. The automatic recorder cuts off and ejects the received copy without assistance. With the great speed of 3000 words per minute, faster than speech, the High Speed Fax is hailed as the "communication marvel of tomorrow."

While improving our facilities for telegraph traffic we have at the same time brought the improvement of high-speed switching arrangements to a number of industries who operate their own private wire systems. Thus without automatic telegraph reperforation equipment we furnish a leased service, like a small telegraph company within itself, to a number of customers. Largest of these include the U.S. Air Force, U.S. Steel, General Electric, United Air Lines, Kaiser Industries, Sears Roebuck, and almost all of the large banks in the country.

Of course, in addition to the large leased reperforator systems there are numerous smaller ones and a whole host of leased wires used by customers to direct stock-brokerage businesses, trucking lines, and miscellaneous warehousing systems. The development of automatic book-keeping and accounting machines operable by the same type of perforated tape used for our telegrams has opened up a large field for the transfer of information in condensed form over telegraph wires.

Intrafax

Our latest development to speed up intra-company communications and thus improve the efficiency of all lines of business is the "Intrafax", an adaption of our Desk-Fax message distribution system. Utilizing facsimile equipment which has already been received with great enthusiasm by business men for telegram transmission purposes, the "Intrafax" apparatus can be assembled in sections to take care of large or small installations, to interconnect many offices or a few. Operated with extreme simplicity by employees of the subscriber, this type of equipment is in use by banks to verify signatures in central files for branches; by stores transmitting facsimiles of the original sales tickets to order delivery of goods from warehouses to customers; by air lines to handle recorded information between offices and air-held centers; and for other purposes where quick and accurate written or diagrammed information is essential. The uses in which "Intrafax" will be valuable seem almost limitless.

In connection with the general transmission of records without physical transfer of material, we are currently working on a facsimile scanner that will enable distant copying of records stored in vaults or in libraries without removing the pages of their binders.

Wherever the need for record communication arises, Western Union has devised means for its accomplishment by telegraphic methods. We have thus literally "grown up" with the country as the requirements of commerce have expanded from border to border and from sea to sea. Our operations have increased in complexity and scope in step with the tempo of technology which has caused us to successively overcome competition from the stage coach, the "Super Chief", and "Flight 99". We expect to meet with atomic-powered devices any day and will be ready, as always, to keep up our end of the bargain.

In the time of Samuel Morse, communications were just beginning to develop beyond the manpower stage. Much of his early development work was carried on in New York University on Washington Square. Were Morse to stroll on McDougal Street today, as he undoubtedly did in the past, he would see the Empire State Building tower with its prophetic spire carrying TV and FM antennae almost a quarter-mile above the street. Once again he could marvel at the developments of his telegraph industry today. I feel sure he would repeat the immortal phrase of the first telegram—"What Hath God Wrought?"

founder and vice-president of High Standard Manufacturing Co., New Haven, Conn., which from 1940-48 manufactured machine guns and small arms. From 1922-37, he was secretary and treasurer of the US Polo Association.

Leland Alric Houghton Merrihew, M.E. '10, 37 Burnham Street, Belmont, Mass., April 13, 1954. He was for many years sales and engineering manager of the Boston branch of Strong Carlisle & Hammond Co., Cleveland, Ohio.

Thomas Harvey Skinner Andrews, M.E. '10, Everdale Road, Randolph Township, P.O. Box 654, Dover, N.J., May 23, 1954. He retired last August after twenty-one years as an engineer analyst with Esso Shipping Co., Standard Oil Co. of New Jersey. Sisters, Ethel M. Andrews '04, Mrs. Bernhard E. Fernow, Jr. (Bernice Andrews) '04. Sigma Phi.

Adie Kyle Bell, B.Arch. '14, April 13, 1954. His address was 314 Wayne Street, Hollidaysburg, Pa. Zeta Psi; Quill & Dagger.

Donald C. Miller, M.E. '12, April 6, 1954. He retired last December as sales engineer with Griswold Manufacturing Co., Erie, Pa., where he lived at 1680 West Twelfth Street.

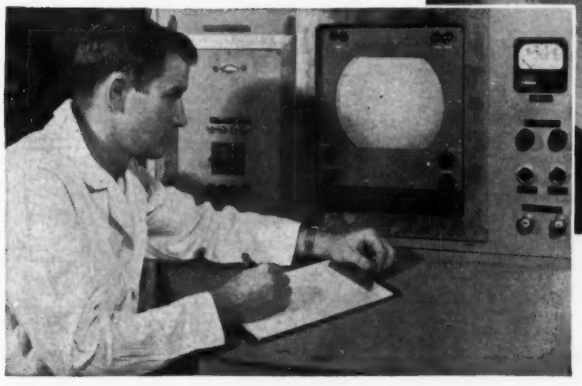
Erwin Louis Wilke, M.E. '12, in May, 1954. He was secretary-treasurer of Hammond Lead Products Inc., Hammond, Ind., where he lived at 7245 Forest Avenue. In 1919, he and his brother, William L. Wilke '09, founded Metals Refining Co. in Hammond. Phi Gamma Delta.

William Harold Chapman, M.E. '13, April 21, 1954. He retired last year as director of engineering at Hyatt Bearings Division of General Motors Corp., Harrison, N.J. He lived in Freelom, N.H. Alpha Sigma Phi.

Alger Daniel Couch, M.E. '13, August 3, 1953. He lived at 139 Haddon Place, Upper Montclair, N.J.

Harold Jenkins Dudley, C.E. '22, 21 Florida Road, Towson, Md., April 30, 1954. He was a general contractor and construction engineer in Baltimore for more than thirty years. Daughter, Joan Dudley '52; son, Carl S. Dudley '54.

ALLISON Engineers Pioneer VTO Power Plant Development



GEORGE D. KEMP, who received his B.S. in Mechanical Engineering from Colorado A. and M. last June, is shown recording data on the engineering log sheet from the industrial TV screen in the VTO test cell. George—now in the Test Operations group in the Experimental Test Section at Allison—is working on the T40 turbo-prop engine which powers the Convair XFY-1 and the Lockheed XFV-1 vertical take-off aircraft.

● Early in '51, Allison undertook the power plant development for vertical take-off airplanes following the Navy's request for a high-power, low-weight turbine engine which could be adapted to vertical operation.

With modifications, the Allison T40 turbo-prop engine—with its extremely high power-to-weight-ratio—was selected to do the job. The vertical operation necessitated basic design changes, such as changing the oil system so it would function in both vertical and horizontal positions. Too, it was necessary to modify the reduction gear, giving a higher propeller RPM and increased thrust. And, with the specially designed propellers required by the VTOs, the control system was redesigned.

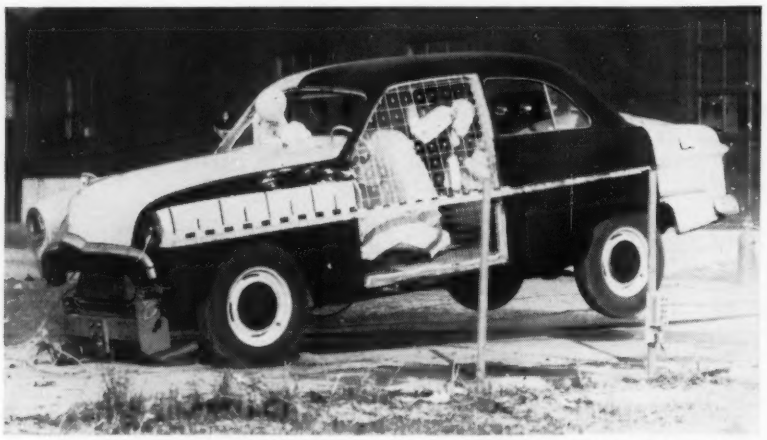
Then, to test the engine, a radically new test stand was designed and built. Allison engineers converted a test stand previously used for low horsepower reciprocating engines to one (shown above) capable of accommodating VTO engines in the various positions from horizontal to vertical. With the huge 72,000 pound tunnel completely enclosing the engine and propeller, a television was installed in the control room so engine operation could be observed in any tunnel position.

The VTO power plant project is typical of the variety of challenging problems handled by the Allison Engineering staff. And, because it is continually pioneering in advanced engineering developments, Allison needs additional technically trained men, especially young graduate engineers. Why not plan now for your engineering career at Allison. Write for information:

R. G. GREENWOOD, Engineering College Contact,
ALLISON DIVISION, General Motors Corporation,
Indianapolis 6, Indiana.

College News

Prof. Arthur R. Kantrowitz, professor at Cornell's Graduate School of Aeronautical Engineering, has been appointed consultant to All American Engineering Co., Wilmington, Delaware. Dr. Kantrowitz, noted physicist and aeronautical engineer, has been credited with many aviation developments, especially in the areas of gas dynamics and supersonic axial flow devices. A Fulbright Scholar and Guggenheim Fellow, Dr. Kantrowitz has published a number of advanced technical books and papers on many aeronautical subjects in the field of shock waves, jet propulsion, and castering landing gear. He will assist All American in the development of engineering projects now being undertaken for the company's many industrial and government clients.



—Durez Plastics and Chemicals, Inc.

Dummies react violently during peak moment of simulated auto crashes conducted by the Laboratory's Industrial Division.

Federal Positions Available

New examinations have been announced by the United States Civil Service Commission for Engineer (various options) and for Aeronautical Engineer, Naval Architect, Marine Engineer, and Welding Engineer. The positions to be filled pay from $3,410 to $10,800 a year in various Federal agencies in Washington, D.C., and vicinity.

For further information, including instructions on where to send applications, consult the examination announcements. Information on examinations may be obtained from most post offices or from the U.S. Civil Service Commission, Washington 25, D.C.

Teagle Hall Opened

Cornell's new men's sports building, Teagle Hall, was dedicated at informal exercises on May 17.

The structure was presented to the university by the donors, Mr. and Mrs. Walter C. Teagle of Byram, Conn. A public ceremony at 2:30 p.m. included sealing of the cornerstone and unveiling of a commemorative plaque.

The native stone building, located in the center of Cornell's sports fields and adjoing Barton Hall, Schoellkopf and the Grumman Squash Courts, has been two years in construction at a cost of $2,000,000.

Its completion gives the university a modern structure to replace the Old Armory, erected before the turn of the century and long inadequate for the growing men's physical education program.

Major features of the new recreation center include an exhibition swimming pool with space for 950 spectators, and a second, shallow-water pool for instruction; a rowing room, with two moving-water tanks; a gymnasium adaptable to four basketball courts or a larger number om badminton or volleyball areas; and special quarters for wrestling, boxing, fencing and corrective exercise.

Among the unusual features are underwater "coaching ports" in the exhibition pool and a passageway, under Garden Avenue, to connect with the drill building, Barton Hall, which will continue to be used for varsity basketball games, wrestling matches and indoor track meets.

Sports buildings on campuses around the country were analyzed in planning the new structure. Members of Cornell's engineering faculty designed the rowing tanks.

Mr. Teagle, former chairman of the board of Standard Oil Company (New Jersey), is a Cornell trustee and an alumnus of the class of 1900. In addition to presenting the building on Monday, he and Mrs. Teagle participated in the christening of a new rowing shell, the Walter C. Teagle.

C.A.L. Studies Auto Crash Fatalities

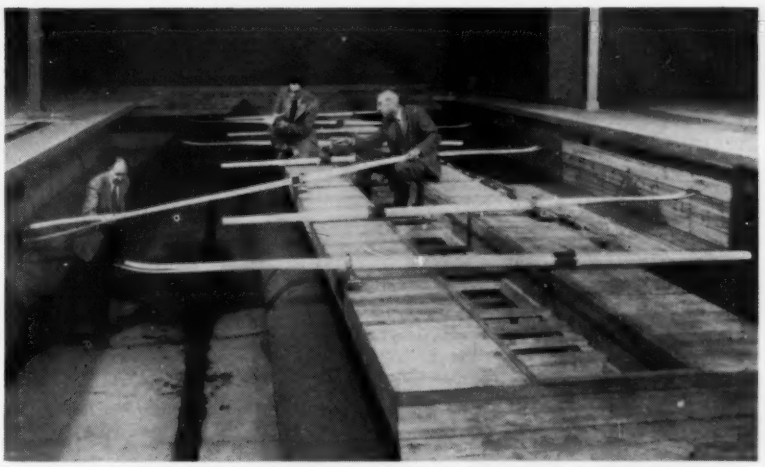
Sometimes, from the twisted wreckage of all but demolished automobiles people crawl out and walk away. Headlines call such survivals miraculous, but they are not miraculous at all. If the exact details of the crash were known and analyzed, it would be found that the laws of physicis and engineering were still operative.

Whether an automobile crash is survivable or not depends on many factors. Popular opinion would have it that the degree of bodily injury resulting from an accident is related only to the speed and violence with which the crash occurs. This, however, is ony a part of the story. Limited statistics available show that close to half the deaths resulting from automobile accidents happen at speeds of no more than 40 miles an hour — a speed at which stunt drivers crash head-on without injury. Steering wheel columns that become spears, door locks that pop open, or protrusions on the dashboards or other interior parts of the cars are often just as critical

factors as the matter of speed in an automobile crash. For example, tests run at the Aeronautical Laboratory have shown that the energy required to fracture the skull on a dashboard control knob is only a fraction of the required for fracture against a smooth hard surface such as an instrument panel. The particular importance of such information can be comprehended when it is known that three out of every four fatalities in automobile crashes result from head injuries.

As one aspect of C.A.L.'s broad program of research in the field of transportation safety, the Industrial Division is investigating for the Liberty Mutual Insurance Company the detailed manner in which bodily injury occurs in automobile crashes, with the ultimate objective of establishing engineering design criteria that will greatly alleviate the effects of crashes when they unfortunately do occur. From pictures it is possible to determine the *velocity* (and hence the energy) with which dummies strike, *where* they strike and *how* they strike. Correlation of the energy of the blow with other data being obtained on the injury potential of various projections within the car establishes how lethal any given blow is. Such information, coupled with the data being accumulated on the frequency with which various parts or objects in the interior of the car are struck, is providnig a sound basis for redesigning automobiles for increased safety. Two programs, involving the redesign of the automobile compartment forward of the front seat in one case, and the use of such protective equipment as seat belts and steering wheel chest pads in the other, are aimed at this specific objective. The Laboratory has still another program under way in its Flight Research Department that is approaching the problem of automotive safety by investigating means of improving the handling characteristics of automobiles. This work involves the application to automobiles of techniques and methods developed for aircraft, and should prove an excellent example of the advantages in exchanging technical knowledge between two related fields.

The Laboratory has also been actively engaged over the past eight years in the field of aircraft safety. Currently the Industrial Division is developing a system for the rapid control of in-flight nacelle fires, as well as an intermittent, high-intensity, airborne lighting system for the emergency landing of aircraft. As a part of the Laboratory's internal research program, the Special Projects Department is formulating and applying systems analysis methods to the solution of commercial air safety problems.



The specially designed oars which will be employed are demonstrated to Cornell Engineers by Coach Stork Sanford (right) in the crew room of Teagle Hall. Prof. Lincoln Reid (left) and Prof. George B. Lyon, Cornell hydraulics engineers, worked on the design of the tanks, which will simulate natural water conditions.

Industrial Engineering Seminar

Cornell University held its first Industrial Engineering Seminars, to discuss problems of manufacturing planning and control, from June 15-18.

The conference was sponsored by the Department of Industrial and Engineering Administration in the Sibley School of Mechanical Engineering. Prof. Andrew Schultz Jr., department head, was chairman of the project and Prof. R. E. McGarrah was coordinator.

The four-day program included workshops in five fields: industrial management, manufacturing engineering, small plant management, work measurements, and applied industrial statistics.

At luncheons for all delegates, talks were given by Walker Cisler, president of Detroit Edison Co., and Matthew Murphy, editor of Factory Management & Maintenance.

At other combined sessions, Allan H. Mogensen,, industrial consultant, spoke on "Work Smarter, Not Harder," and William L. Gomberg, management engineering director for the International Ladies Garment Workers Union, outlined "Problems in Industrial Management."

At the closing session, Prof. Harry J. Loberg spoke on "Where Do We Go From Here?" He is director of Cornell's Sibley School and also sales training director for the National Machine Tool Builders Association.

The workshop on Industrial Management discussed current problems in line supervision, cost accounting, production scheduling and control, materials control, and personnel administration.

New manufacturing developments and their application to current production problems were discussed in the Manufacturing Engineering seminars.

The group on Small Plant Management covered basic industrial engineering techniques for better management control in firms too small to have specialized engineering staffs.

Newest improvements in work measurement techniques, supplementing the traditional timestudy methods, were explained in the Work Measurement meetings.

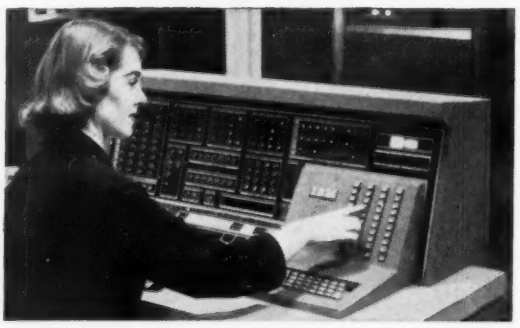
In the sessions on Applied Industrial Statistics, the leaders explained some methods of industrial

MR. MORSE PUTS HIS INVENTION TO PRACTICAL USE

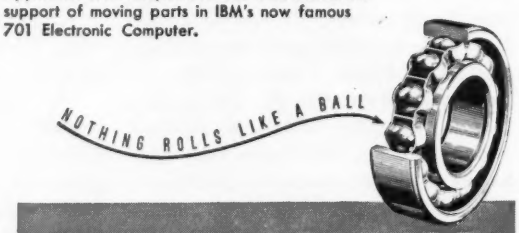
Actually, Morse's first message over his electric telegraph was, "What hath God wrought?" Ever since, it's helped solve the problem of getting money from home . . . and a good many other problems as well.

Inventor Morse wouldn't recognize some of the latest developments in his field. Automatic coding and decoding machines. Radar. Electronic computers. Such devices depend on **ball** bearings to maintain moving parts in accurate alignment, cut friction to the minimum and reduce wear.

In every field . . . designers and engineers call on New Departure for the finest in **ball** bearings. For New Departure manufacturing is known to employ advanced methods of automation, integration and quality control.



IBM's latest brainchild, the 702 Electronic Data Processing Machine, is an outstanding example of New Departure **ball** bearing application. New Departures also assure accurate support of moving parts in IBM's now famous 701 Electronic Computer.



NEW DEPARTURE
BALL BEARINGS

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT

LAVA

Manufacturers of Super-Refractories Only

◆ ◆ ◆

REFRACTORY CRUCIBLES
GRAPHITE CRUCIBLES
HIGH TEMPERATURE CEMENTS
SPECIAL REFRACTORY BRICK, TILE, SHAPES

◆ ◆ ◆

From the Following Materials:—

GRAPHITE —— SILICON CARBIDE —— FUSED ALUMINA —— MULLITE
MAGNESIA ZIRCON

◆ ◆ ◆

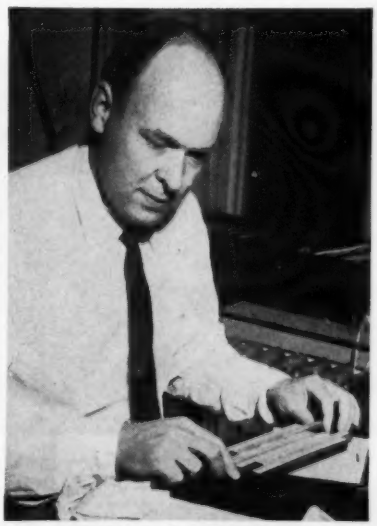
LAVA CRUCIBLE-REFRACTORIES CO.
PITTSBURGH, PA.

statistics and their application. No training in statistics nor mathematics was needed.

Cornellians Study Ionosphere Propagation

The mass of wires strung on poles at the Kline Road Ionosphere Laboratory of the School of Electrical Engineering performs at television frequencies the same function that a searchlight, or automobile headlight, performs at light frequencies. A television-like antenna atop the telescopic centrol mast is the "bulb" and is connected by means of a cable to a 200 kilowatt radio transmitter. This antenna "illuminates" a parabolic mirror a hundred feet in diameter constructed from parallel copper wires suitably strung between a circular ring of powerpoles. With a rope connected to the top of an old radio station broadcasting tower, the central mast may be lowered so as to bring the antenna at its top to an elevated platform at the edge of the mirror. The mirror directs a beam of radio waves vertically upwards towards the ionosphere in an experiment designed to probe by radar the layers of the outer atmosphere that are responsible for reflecting radio waves.

The project is sponsored by the Evans Signal Laboratory of the U. S. Signal Corps and is under the direction of Dr. H. G. Booker. This experiment was instituted by Prof. B. Nichols and involves graduate students R. Cohen and G. Rumi. Rigging of the mirror was carried out by John Ewanicki, who may frequently be seen at work on the campus trees, his usual occupation. It is hoped that the experiment will throw light on the mechanism of regular long-distance propagation in the low-frequency television-band. The possibility of such long distance propagation came to light a year or two ago partly as a result of the work of the Cornell Ionosphere Laboratory.

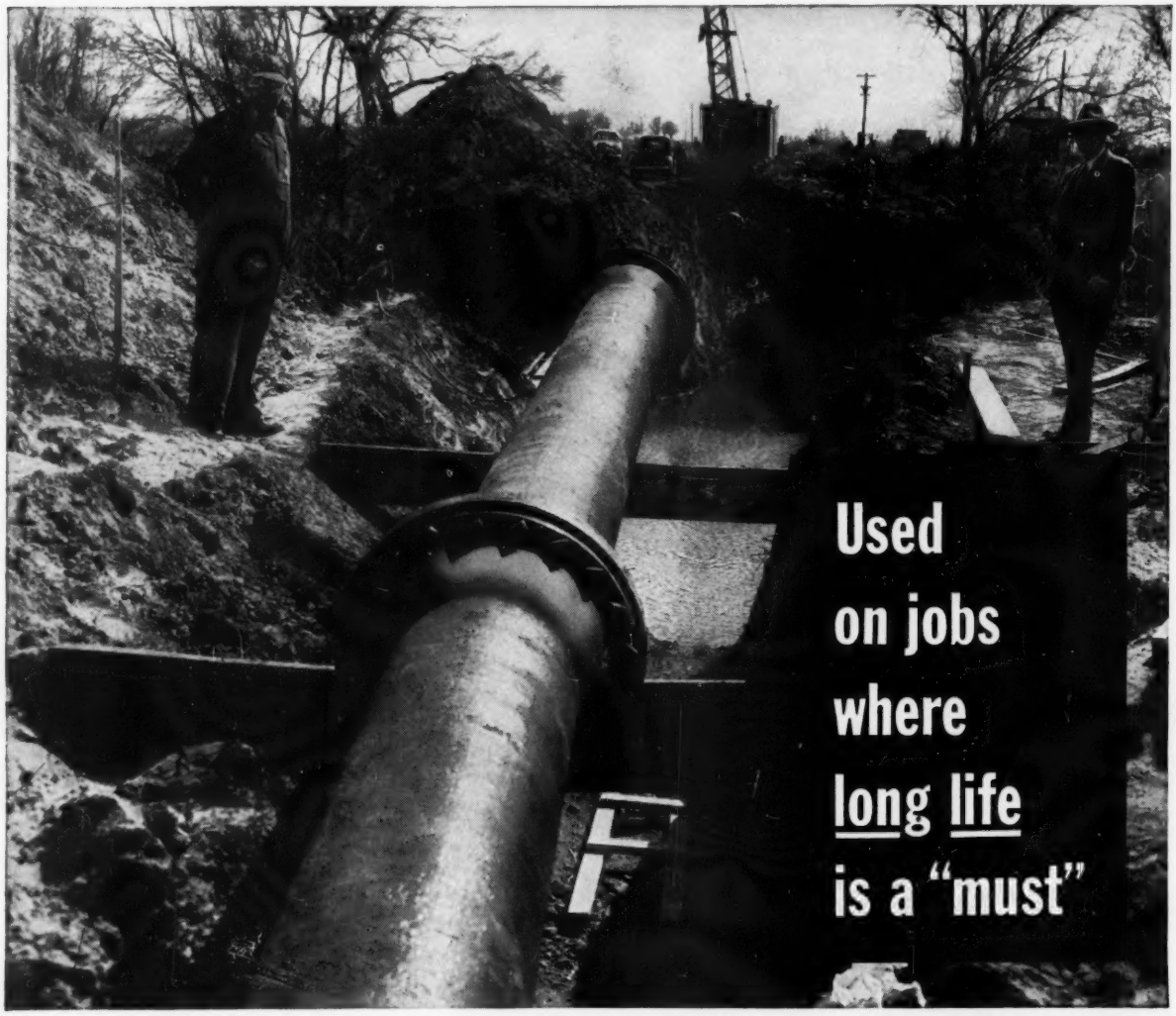


Prof. Andrew Schultz

A.S.M.E. Awards

Three Cornell mechanical engineering students won prizes for their papers in a contest sponsored by the student branch of the American Society of Mechanical Engineers.

First prize of $25 went to Daniel M. Isaacson for a paper on "Design Problems and Automatic Folding and Non-rigid Materials." Henry L. Stein won second prize of $15 for a paper on "A New Use for Low-temperature Refrigeration," and Barry D. Kolton third prize of $10 for "An Engineering Product Analysis."



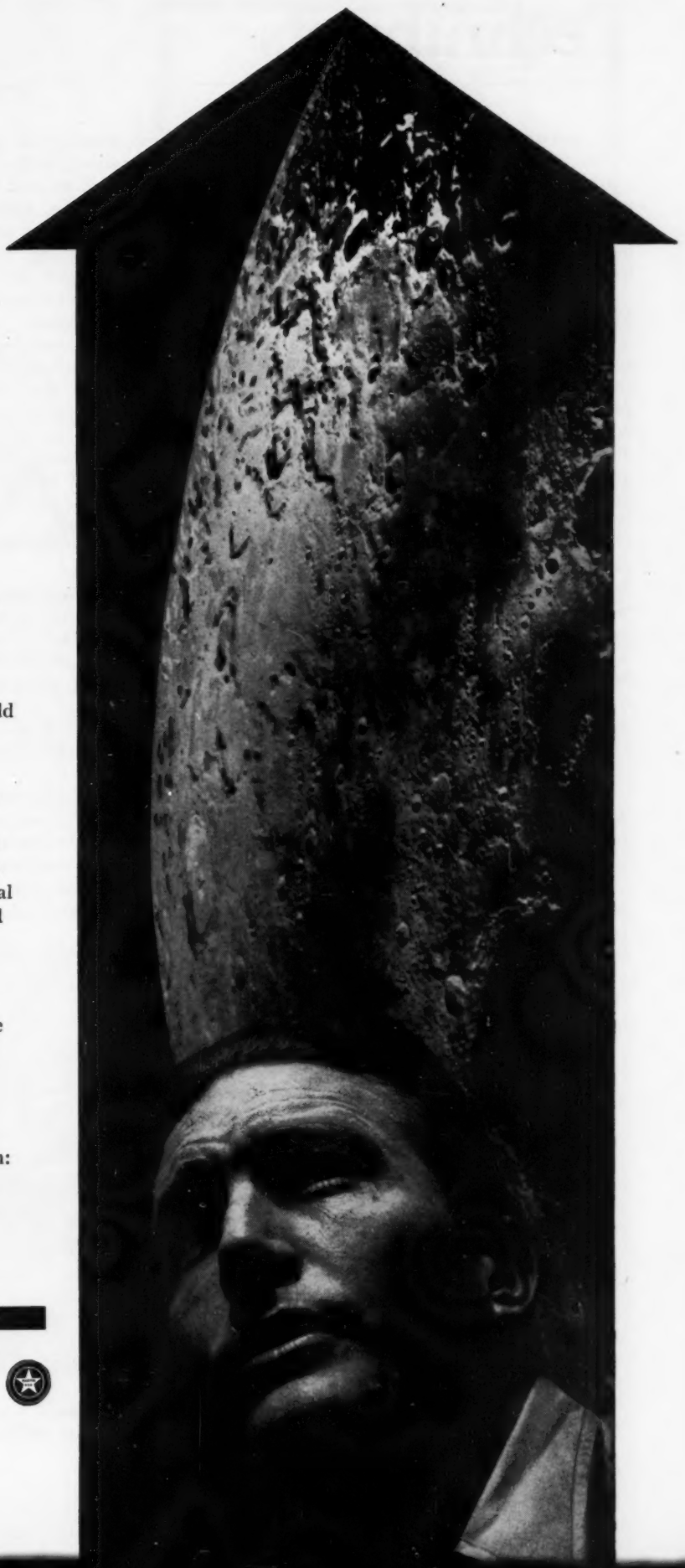
Installing cast iron mechanical joint pipe across river at Salina, Kansas, for sewer main.

When an installation, once completed, should be as trouble-proof as planning and materials can make it — engineers rely on cast iron pipe. It has high beam-strength, compressive-strength and shock-strength. Its effective resistance to corrosion ensures long life, underground or underwater. These are reasons why cast iron pipe is so widely used for water lines in tough terrain, pressure and outfall sewers, river crossings, and encased piping in sewage treatment and water filtration plants. Cast Iron Pipe Research Association, Thos. F. Wolfe, Managing Director, 122 So. Michigan Ave., Chicago 3, Ill.

This 123-year-old cast iron water main is still in use in the distribution system of St. Louis, Mo.

CAST IRON

CAST IRON PIPE SERVES FOR CENTURIES



tonight

This man could almost reach the moon tonight... for he stands at the brink of a new age in the conquest of space, and he knows this:

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Technibriefs

Protection of workmen against carbon monoxide inside air-supplied concrete or steel caissons on construction projects is assured by an alarm system installed on air compressors by the Kansas City Bridge Company, Kansas City, Missouri.

The alarm system consists of one MSA Carbon Monoxide Alarm unit installed on a manifold between compressors and a common air receiver tank. If carbon monoxide is present in air supplied to the receiver via the manifold, the MSA alarm automatically will detect it and issue a warning by visible and audible signals integral with the compact alarm unit.

Personnel in charge of the compressors then valve off the supply lines to the manifold to determine which compressor is supplying the carbon monoxide-contaminated air. The alarm is calibrated to sound a warning at low concentration of CO —in plenty of time to evacuate personnel through a decompression chamber if the trouble is not remedied immediately.

Completely self-contained in a weatherproof metal case, the alarm can be furnished for operation from 110 volt AC or DC current. The alarm operates continuously and will detect and warn of CO concentration as low as two parts in 10,000 parts of air, the point at which a few hours of exposure would be required to produce the first symptoms of carbon monoxide poisoning.

The only maintenance required for the alarm unit is periodic replacement of Hopcalite. Testing the apparatus is also no problem as the workmen need only blow cigarette smoke into the alarm's intake at frequent intervals. The CO present in the smoke sets off the alarm.

Jet Silencers

Three advanced silencer units for ground operations of the nation's newest and most powerful jet airplanes and engines have been added to North American Aviation's sound abatement system at the company's fighter assembly line at Los Angeles International Airport.

The new facilities will be used in ground operations of the F-100 Super Sabre, first production airplane capable of exceeding the speed of sound in normal, level flight, and for acceptance testing of its Pratt-Whitney J-57 engines.

Eight other sound reduction units are in use by North American for ground operations of the F-86 Sabre Jet series. The first of the silencers was placed in operation during 1948, and the other improved units were added with advances in airplane designs and new developments in jet power.

The system was built at a cost of more than $1,600,000.

Largest of the three new silencers is a $261,000 chamber for testing the J-57 power plants. The jet engine develops 10,000 pounds of static thrust, the most powerful U.S. jet to date.

Engines operating at full power are barely audible 250 feet from the abatement unit.

Sound of the engine during run-ups is contained by the chamber's three feet thick walls. Constructed of corrugated steel plates one-eighth of an inch thick and separated by tons of sand, the walls are slightly elastic and absorb the sound energy of the operations.

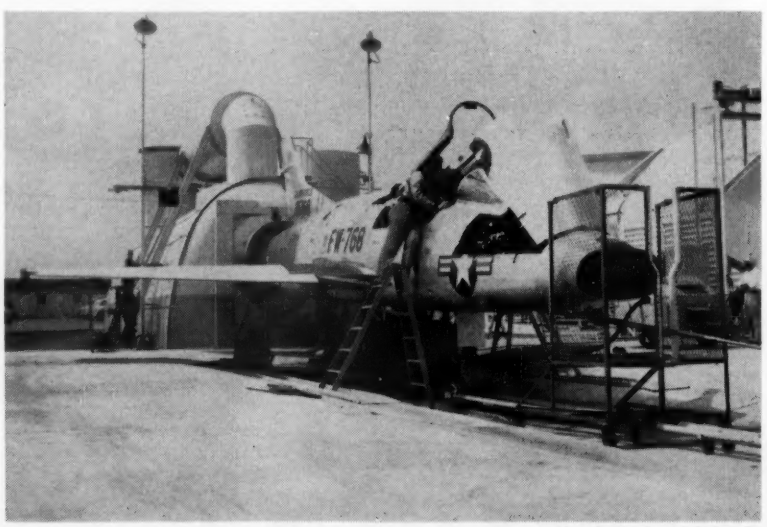
A 45 feet long muffler, six feet in diameter, catches more of the sound and is water-cooled to absorb nearly all of the 3,500 degrees of heat produced by full-power operations. An automatic water ring sprays 480 gallons of water a minute into the muffler, where the heat so nearly evaporates the liquid that only a few wisps of steam are visible from the chamber's exhaust stack.

Air is sucked into the chamber and the mouth of the powerful jet engine through 6 inlet silencers on the roof of the test facility. The openings admit 100 pounds of air each second, enough to change the air in 50 homes every second.

During the acceptance testing, the engines are operated from two instrument panels in a control room outside one wall of the test chamber. Technicians watch the operations through two large observation windows constructed of four panels of bullet-proof glass.

Mirrors mounted on the internal walls of the chamber give the technicians a clear view of each external part of the engine.

The two other units for ground operations of the F-100 Super Sabre



—North American Aviation, Inc.

The tailpipe of the F-100 Super Sabre juts through an opening of the silencer unit where it is fitted with a nearly sound-proof asbestos collar.

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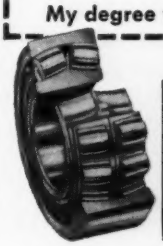

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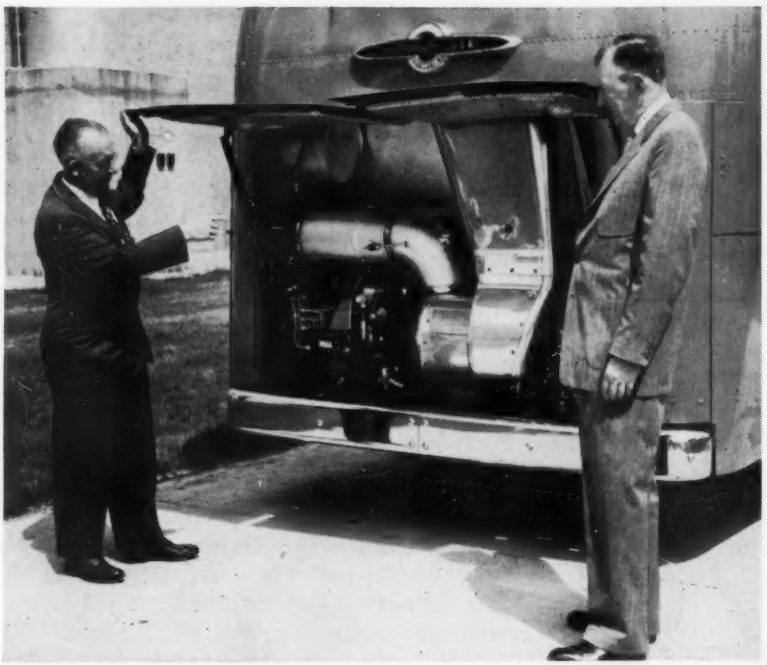


A GMC transit bus, with its conventional Diesel engine replaced by a gas turbine unit, is being tested by General Motors Research Laboratories to explore possibilities of the gas turbine in the commercial or heavy duty field.

utilize similar test chambers and silencer systems, and were built at a cost of $85,000 each. The tail pipe of the Super Sabre is fitted into an opening in the unit and surrounded by a huge "washer" of asbestos cloth. The engine is operated from the cockpit of the super-sonic fighter.

Cal Windtunnel Program

Cornell Aeronautical Laboratory, Inc., has announced a major wind tunnel modernization program that will double the power of its large variable density tunnel and permit further exploration of the troublesome transonic speed range.

The project, sponsored by the U. S. Air Force and administered by the U. S. Army Corps of Engineers, will cost $1,600,000.

It calls for an increase from 15,000 to 30,000 horsepower and change to an 8- by 10-foot transonic throat section of Cornell's original design. The section will be used for study of airplane and missile models up to speeds 1¼ that of sound.

The Cornell transonic perforated throat will permit testing of models with wing spans up to five feet—much larger than are now considered possible in other tunnels of similar size in the nation.

A laboratory spokesman said the changes in the wind tunnel will provide an experimental tool that will be used for years to come in solving problems of transonic flow, one of the aeronautical engineer's greatest headaches. Experts feel that the slower speeds (subsonic) and the higher speeds (supersonic) are adequately understood for the present. However, the uncertainties of air flow at transonic speeds (at or above the speed of sound) present a new frontier of aerodynamics.

The transonic range is from .9 to 1.2 the speed of sound (about 700 to 900 miles an hour at sea level.).

The Cornell transonic throat is a unique method of testing models at the speed of sound that was invented under an internal research project of the Laboratory and further developed under Air Force sponsorship.

Engineers have had trouble with the "choking" of the tunnels when they roared at the speed of sound. Shock waves bounced back from the walls and interfered with the airflow around the test model. Thus, data collected were useless.

Cornell experts found that by "perforating" or putting thousands of tiny holes along the walls of the tunnel throat the reflection of shock waves from the wall could be alleviated. In order for the perforated wall to accomplish its purpose, the boundary layer adjacent to the wall is diminished or thinned by suction. Boundary layer is a thin layer of slow-moving air caused by friction next to the tunnel wall. This same suction for reducing boundary layer is used to achieve an airflow greater than the speed of sound. A 3- by 4-foot perforated throat has been in operation at the Laboratory for a year and a half. Details are secret.

Plans for modernization of the tunnel, which has been in operation since March 1948, were made by the Wind Tunnel and Plant Engineering Departments. The original design of the transonic throat was a joint effort of the Laboratory's Aerodynamic Research and Wind Tunnel Departments.

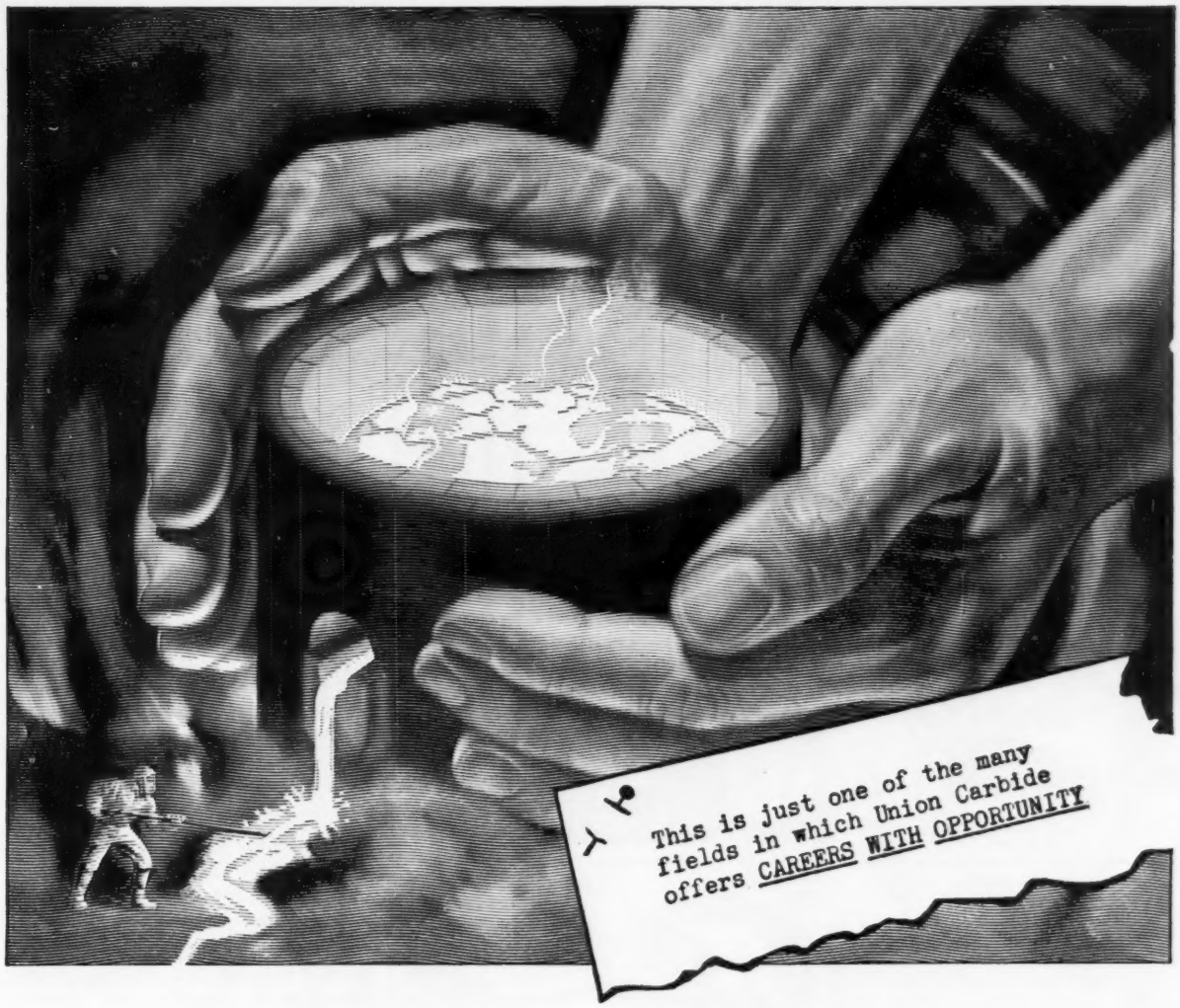
Atom Submarine's Atmosphere is Continuously Purified

When the Navy's atom-powered submarine, the Nautilus, is buttoned up for diving its crew must, of course, work in a non-toxic atmosphere. So a carbon dioxide removal unit is among its facilities.

When the unit is placed in operation, the air of the submarine is passed through an absorber column. There it meets a countercurrent stream of the absorbing medium, which removes the carbon dioxide. Then the absorbent is reactivated in a separate vessel and recycled. Thus, excess carbon dioxide is continuously extracted from the atmosphere.

The carbon dioxide is released from the reactivator, with some rejection steam, by the application of heat in the reboiler. Compressed, it is exhausted into the sea where it dissolves and leaves no bubbles to reveal the submarine's position The heat of compression is recovered in the reactivator boiler before the carbon dioxide is expelled. The effect is to reduce appreciably the outside heat load needed for continuously reactivating the absorbing solution.

The unit has a high capacity for absorption of carbon dioxide in relation to its size and weight and



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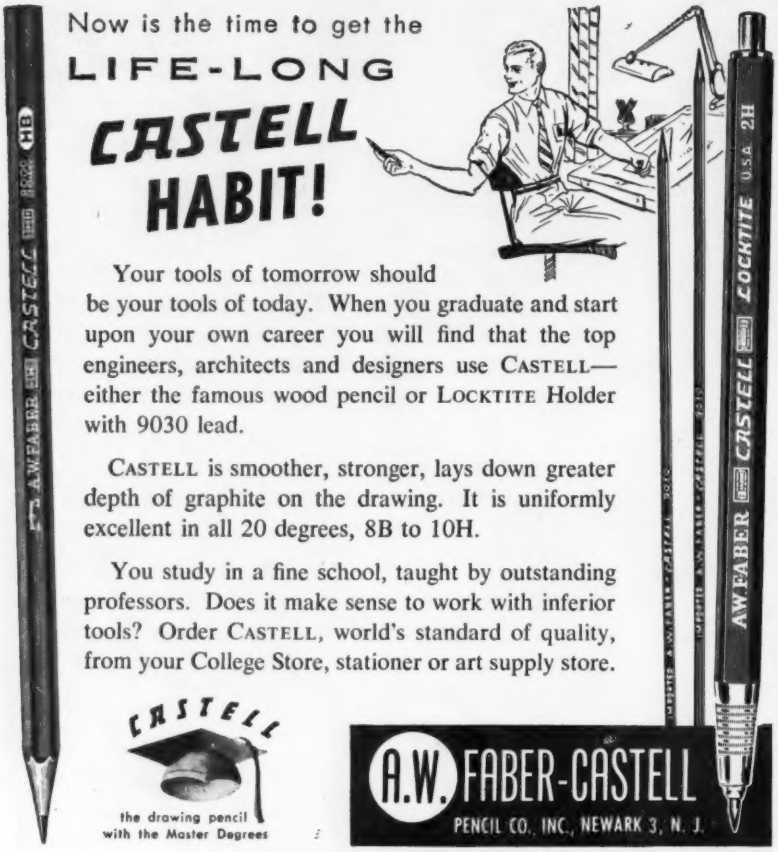

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the volume of absorbent employed. It is fabricated mainly of thin-wall stainless steel.

Pint-size Atomic Pile

A pint-sized atomic pile, "little brother" to the big ones used to make plutonium for atomic bombs, has been placed in operation as a research tool at the Knolls Atomic Power Laboratory, Schenectady, N. Y., which is operated by the General Electric Company for the Atomic Energy Commission.

The new low-power nuclear reactor, in contrast to huge reactors at the company's Hanford Works, Richland, Wash., is contained in a cube of graphite measuring only five feet on a side, according to Dr. Kenneth H. Kingdon, technical manager of the Knolls laboratory. It appears not much larger than a bank of four ordinary, office filing cabinets.

While a low-energy reactor of this sort cannot be used for making plutonium, or for the production of atomic power, it is a useful source of neutrons, which can be utilized in many fields of fundamental research.

A unique feature of the reactor is an internal "thermal column," where the neutron flux is much greater than in the fuel region surrounding it. Fundamental properties of the various kinds of atoms which are placed in this column can be quickly and easily determined. This facility can be used to detect minute amounts of many elements, quantities considerably below the capabilities of ordinary methods of analytical chemistry. At comparably lower reactor power levels, it can also make small quantities of radioactive forms of elements that are ordinarily non-radioactive, i.e. "radioactive isotopes". The reactor fuel is in two-inch disks of an alloy of uranium and aluminum, strung on rods like beads on a string and kept apart by plastic separators. Each rod, about 18 inches long, is hung in a can containing a light paraffin base oil. There are 20 such cans in a circle, with water between them.

In the middle of the ring of fuel cans is a graphite cylinder 12 inches in diameter, with a test hole in the center. Materials to be tested or to

be exposed to neutrons are placed in this hole, where they are subjected to a strong neutron bombardment as the reactor is operated. In addition, materials can be inserted into the reactor through a horizontal hole from outside the protective walls, which extends close to the fuel assembly.

Control of the device is accomplished with rods and sheets of cadmium which can be lowered into the fuel assembly. These blot up neutrons and so prevent them from carrying on the chain reactions. Other safety rods are provided which drop automatically into place when needed.

As installed at the Knolls Atomic Power Laboratory, the device is inside a cell 10 by 15 feet, surrounded by a six-foot-thick concrete wall. Access to the cell can be attained through an opening three-feet-wide with a motor-operated concrete door. This door must be closed and locked before the reactor can be operated.

In using it to detect minute amounts of certain elements, the reactor is first operated at a uniform level. Then, by remote control from outside the cell, the test sample is lowered into the central test hole. Depending on the material, there will be some additional absorption of the neutrons thus slowing down the operation of the reactor. Then the control rods are withdrawn to restore the original operating level. From their settings, as compared with their previous positions, minute amounts of elements affecting the operation can be detected.

Space Travel and Science

Astronauts should be welcome in the "respectable" scientific and engineering societies, and problems of space travel should be discussed in their journals, according to Theodore von Karman, chairman of the U. S. Air Force scientific advisory board and one of the world's leading figures in aerodynamics.

Concluding his book on "Aerodynamics" which was recently released by the Cornell University Press, Dr. von Karman states that the astronautical and interplanetary societies of today are much more scientific than the aeronautical societies of the late 19th century.

Although criticizing "reckless promotion," Dr. von Karman says that it may take no more effort to develop a manned space rocket than it took to develop today's supersonic aircraft from the Wright brothers' plane of 1903.

Serious attempts to build a space ship, however, probably have to wait until the nuclear rocket is developed, Dr. von Karman believes. Nuclear energy could efficiently provide the speed of seven miles a second needed to escape the earth's gravitational forces, he says.

Safe return to the earth or safe landing on another body, he states, remains the basic problem. A rocket's speed when it re-enters the atmosphere would heat it beyond the endurance of any known material, he explains.

The medical or biological problem of a "weightless existence"—living in a gravity field of nearly zero intensity—needs much research, but Dr. von Karman believes medical people may be too cautious. He mentions that doctors in 1783 worried about altitude effects in balloon flights.

Other research that must precede space travel, Dr. von Karman writes, includes basic studies of aerodynamics and the physics of rarified, ionized gases; exploration of the highest altitude reachable of sounding rockets; study of radiation effects on materials and humans; navigation and guidance problems; and development of unmanned rockets.

Dr. von Karman's book covers aerodynamics since the time of the development of the science of Newton, and especially the discoveries of the past 50 years.

Behind-the-scenes research that enabled the visible improvements in airplane design, performance and safety are outlined—problems of lift, drag, stability, aeroelasticity and "breaking the sound barrier."

The book is based on the 1953 Messenger Lectures given at Cornell as part of the 50th anniversary of powered flight. Dr. von Karman is chief of NATO's advisory group for aeronautical research and development and a former director of the Guggenheim School of Aeronautics at the California Institute

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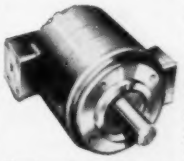

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Heat Sensing Cell

Little slips of glass coated with lead sulfide that can give 10,000 times as much sensitivity to certain infrared rays as previous laboratory instruments have now been put on sale to science and industry.

Known as Kodak Ektron Detectors, the new photoconductive cells were first unveiled at the convention of the American Society for Testing Materials. The company believes that the extreme infrared sensitivity of the cells, coupled with their simplicity and adaptability to manufacture in any size or shape, opens wide new possibilities to engineers in developing new devices based on the ability to detect warm objects without physical contact and over long distances.

Announcement of the availability of the Ektron Detectors culminates a decade of research. Though the cell reaches its peak of sensitivity in the invisible heat rays of the near-infrared, it is highly sensitive to all colors of visible light and on into the ultraviolet.

As a demonstration of the cell, Kodak representatives have been exhibiting a small box that emitted squeals whenever the Ektron Detector on it "saw" the bit of hot ash on the end of a cigarette. It also squealed loudly when a flashlight was pointed at it with battery cells so weak that the lamp filament scarcely glowed.

In addition to its possibilities for heat detection devices and for the replacement of present types of "electric eyes" in rough-service applications, the Kodak company also sees a strong potential for Ektron Detectors in automatic control of chemical processing plant operations and in complex electrical equipment where mechanical switching devices are too bulky, impractical, or insufficiently reliable.

In the chemical plant applications, the cells coulld automatically monitor the exact composition of fluids flowing through pipes and process vessels on the basis of the characteristic infrared "color" of the various components. Water and gasoline, for example, are both colorless liquids to the human eye but look entirely different to a sensitive infrared detector. Very thin differences between chemicals can be detected in this way.

Adoption of International Nautical Mile

Since July 1, 1954, the National Bureau of Standards has used the International Nautical Mile in lieu of the U. S. Nautical Mile. This decision, replacing the U. S. nautical mile of 1853.248 meters (6080. 20 feet) by the International Nautical Mile of 1852 meters (6076. 10333 . . .feet), confirms an official agreement betweeen the Secretary of Commerce and the Secretary to Defense to the International Nautical Mile within their respective departments.

The use of a mile derived from the length of a degree of the earth's meridian is very old. It is believed that the Chaldean astronomers determined the length of such a unit. Miles of this sort have been variously called meridian miles, geographical miles, sea miles, and nautical miles, and they have differed greatly in magnitude, some of the values providing 10, 12, 15, and 60 miles to a degree. The British and the U. S. nautical miles were each derived by taking 60 nautical miles per degree, but the values adopted were not the same. The nautical mile adopted by the British Admiralty equals 6080 British feet, while the U. S. nautical mile has the adopted value of 1853.248 meters, from which the equivalent 6080.2 U. S. feet has been derived. The British foot is shorter than the U. S. foot by 1 part in 400,000, an amount which is of no importance in the ordinary transactions of everyday life but which is very important in precise measurements.

In 1929 the International Hydrographic Bureau obtained an agreement from a large number of countries to adopt a value of 1852 meters for the nautical mile, the unit thus defined to be called the International Nautical Mile. However, at the same time Great Britain, the U.S.S.R., and the United States did not accept this value, each country preferring to retain the nautical mile to which it had been accustomed.

Finally, in 1953 an informal group from the Department of Defense and the Department of Commerce considered a proposal for international standardization of abbreviations for the knot and the mile. At this meeting the general situation regarding the nautical mile was discussed, and the belief was expressed that a change from 1853.278 meters would not affect nautical charts, the calibration of navigational instruments, or navigation. Because there seemed to be no sound reason why the International Nautical Mile should not be adopted in this country, the Departments of Commerce and Defense agreed to accept this value as of July 1, 1954.

Cavity Walls

(Continued from page 12)

of construction the ability of the wall to withstand the impact and rapid cooling action of a fire hose stream is also determined.

Five tests on brick cavity walls performed by the Bureau of Standards show a 5-to 7-hour endurance.[3] Resistance of ten-inch brick and tile cavity walls has been calculated to be in excess of four hours.[4] Both these fire resistances are sufficient to pass the usual fire codes now in existence throughout the country.

To sum up the advantages of cavity wall construction: cavity walls are better insulators; they minimize rain penetration and provide a possible financial saving. They are able to hold their own with other wall types in the fields of strength, fire resistance, and weather resistance. It appears then, that cavity walls are a decided advantage in construction. Perhaps the only deterrent to their more widespread use is the inertia of the construction industry, an inertia which is rapidly being overcome as exemplified by the use of cavity wall for the Cornell University dormitory group.

1. "How To Build Cavity Walls", Part II, Masonry Building.
2. Technical Notes on Brick & Tile Construction, May 1951.
3. Building Material and Structures Report 92.
4. Technical Notes on Brick & Tile Construction, June 1950.

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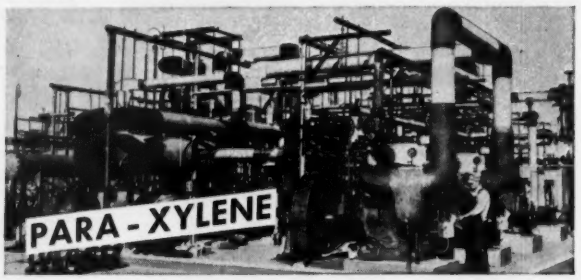
Below Right: Three of the six Frick refrigerating machines in service at Big Spring, Texas.



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Shell Molding

(Continued from page 24)

The use of back-up, or bedding, material during pouring is necessary in most cases to resist distortion of the shell under the hydrostatic head of metal pressure. Steel and copper shot, gravel, and green sand have been found suitable. Back-up material should provide sufficient pressure to prevent shell deformation, permit porosity and gas escape, and should produce no effect on the mechanical properties of the casting.

Experience with metal shot has been the most satisfactory. Differences in the thermal conductivities of different shot materials do not affect the properties of the casting appreciably, provided they are high enough to conduct heat rapidly. Shot is particularly favored over green sand because the voids between particles provide greater porosity. Tests have demonstrated that a variation in the sizes of shot particles provides optimum results. First, diversity of size provides a greater resistance to deflection of the mold wall than uniformity of size, and second, the void space may be varied to furnish the exact porosity desired. Although a wide range of sizes is preferable, it introduces handling difficulties and segregation prolems. A range in which the largest size particle is 2/3 greater in diameter than the smallest produces the best compromise.

Normal casting procedures apply for the pouring of shell castings. Molds may be poured either vertically or horizontally. During pouring, gases are evolved through the shell which darkens as the resin binder decomposes. The shell falls completely from the casting in a semi-powdered form. The burned-out mix may be reclaimed, although present reclamation techniques render recovery uneconomical.

Shell cores are fabricated in much the same manner as mold halves. A resin/sand mix is blown into a split corebox, the patern faces of which are heated to form a crust, which is cured and hardened.

Mechanization

Shell molding is easily adaptable to complete mechanization. Figure 4 shows the foundry layout of the Walworth Company in Boston, Mass., which manufactures valves, threaded pipe fittings and pipe flanges. The foundry is built around an automatic 8-station rotary mold-making machine which turns out 240 shells every hour. The diagram does not include sand-resin conveying equipment to transport the mix to the shell-making machines, mold conveying equipment, a flask filling station, and cooling and cleaning equipment for back-up material, all of which are essential for complete mechanization of the process.

Over ten firms in this country and several more in England produce completely automatic shell-making machines. They may be of two types: a single-stage unit, which incorporates all operations in the cycle in one machine, and a multi-stage unit, a group of machines with separate stations for mold-making, curing, stripping, pattern coating, and preheating. The former utilizes only one pattern plate, the production rate being determined by the complete cycle, while the latter utilizes several plates for con-

(Continued on page 50)

Richard J. Conway, Lehigh '51, selects Manufacturing Engineering at Worthington

RICHARD CONWAY checks cutting tool with machinist before milling a pump casing.

After completing his general training which brought him in contact with all departments, Richard J. Conway decided that manufacturing engineering was his field. He says, "I chose the Manufacturing Engineering Department after completing my general training at Worthington because as a graduate in Industrial Engineering I can learn the practical aspects of my field while applying theory I learned in college.

"The personnel of this department work together as a team toward the solution of the numerous problems which arise daily. We have the cooperation of all other departments in the corporation in getting the necessary facts pertinent to the solution of these problems. In the course of our day it may be necessary for us to meet the Plant Manager, Chief Engineer, Comptroller, several department heads, clerks, foremen, machinists and many others throughout the company.

"I have contributed to the solution of many problems handled by this department including metal spraying, machining procedures, purchasing new equipment and designating proper dimensions to obtain desired fits between mating parts.

"I enjoy my work because I'm doing the work I want and my formal education is being supplemented with practical knowledge gained from the tremendous wealth of knowledge available to me at Worthington. I know from personal contact with many other departments in the Corporation that Worthington can and will find their young engineers a spot which will give them the same opportunities as have been afforded me."

When you're thinking of a good job, think *high*—think *Worthington.*

FOR ADDITIONAL INFORMATION, see your College Placement Bureau or write to the Personnel and Training Department, Worthington Corporation, Harrison, N. J.

WORTHINGTON

The Sign of Value Around the World

Shell Molding

(Continued from page 48)

tinuous function, the investment time determining the production rate. While a single-stage unit may produce up to 60 complete shells per hour, its multi-stage cousin may raise that figure to five-hundred.

Conclusion

The ultimate consideration as regards any manufacturing process is the economic one. Shell molding requires a great initial outlay, for it is highly mechanized, and thus is feasible only when a large volume of production for a specific casting is anticipated. Resin costs are unusually high compared to sand costs; patterns represent the foundryman's greatest outlay — their cost may reach well over $100,000 before production can begin on a certain item. On the other hand, elimination of machining costs, of skilled labor, of sand-handling equipment, and of other costly operations of the sand foundry, maintenance of unsurpassed foundry productivity and saving of floor space may render shell molding advantageous money-wise. It must be emphasised, however, that each case must be judged on its individual characteristics as to the decision which process to use. Shell molding is by far no panacaea for the foundryman's difficulties.

Aero Lab

(Continued from page 20)

a new program of sabbatical leaves with pay to complete work toward a doctor's degree. The Laboratory's own library, housing 96,000 reports, 5000 books, and numerous technical journals, provides a constantly expanding source of valuable information for staff members.

How does the Cornell Aeronautical Laboratory find the solution to one of the varied research problems it encounters?

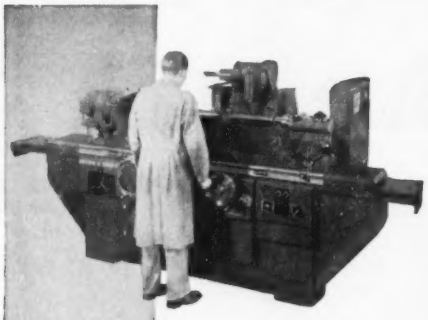
To find the answers to a problem initiated by a sponsor or staff member, a project initially evaluated by Laboratory executives is assigned to the technical department that conducts the type of research in question. Other departments may be assigned to assist, but a single department usually assumes the major responsibility for coordinating and carrying out a project. Within the department the project is assigned to an engineer with special ability in the field required.

The engineer, under direction of his department head, is given the responsibility of directing assigned personnel, developing a plan of attack, preparing reports, and allotting time and money to the problem. He is provided with technical assistance, clerical help, and consultative aid of other Laboratory Departments. An increasing number of recent projects, such as Weapons Systems Studies, involve the entire Laboratory and utilize a special project coordinator and a committee of technical specialists to oversee the program's execution. This individual approach has contributed to the Laboratory's worldwide record of successful technical achievement.

From tractor seats and football helmets to helicopter blades and guided missiles, the program of the Cornell Aeronautical Laboratory is focused on the future. Its researches today are valuable steps toward greater national security tomorrow. Its facilities and competent staff members give industry better products and manufacturing methods to meet the demands of a growing industrial economy. Its cooperation with Cornell University provides a valuable aid to higher education.

Dr. C. C. Furnas, former Director of Cornell Aeronautical Laboratory and now Chancellor of the University of Buffalo, summarizes the Laboratory's role in the years ahead by predicting, "Not only could there be greater utilization of the work by industry for both military and civilian production, but advanced education should also benefit. Direct benefits to the public not alone in new devices, but in safety, comfort, and well-being are potentially there."

Tomorrow's engineering age is a challenge to applied science. Cornell Aeronautical Laboratory is a practical answer to that challenge. Its varied research program previews a better tomorrow through constant technological progress.



DESIGNED for the PLANT of TOMORROW

BROWN & SHARPE "up-to-the-minute" machines have been designed and built for just such plants. They offer improved performance and greater reliability for the mass production of precision parts at lower operating costs. These machines on the production line will integrate high production and high precision.

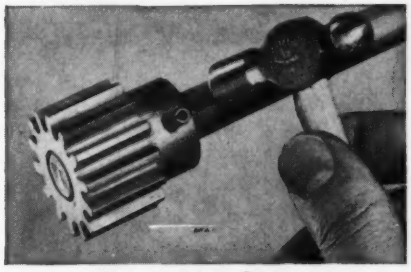
For full particulars on the complete line embracing Milling, Grinding and Screw Machines write Brown & Sharpe Mfg. Co., Providence 1, Rhode Island.

Brown & Sharpe B·S

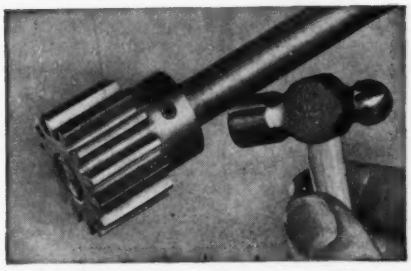
Where will you use this simple fastener?

Rollpin is driven into holes drilled to normal production-line tolerances.

No threading, peening or precision drilling with ROLLPIN



It compresses as driven.



Rollpin fits flush . . . is vibration-proof.

Rollpin is the slotted tubular steel pin with chamfered ends that is cutting production and maintenance costs in every class of industry.

This modern fastener drives easily into standard holes, compressing as driven. Its spring action locks it in place—regardless of impact loading, stress reversals or severe vibration. Rollpin is readily removable and can be re-used in the same hole.

* * *

If you use locating dowels, hinge pins, rivets, set screws—or straight, knurled, tapered or cotter type pins—Rollpin can cut your costs. Mail our coupon for design information.

Elastic Stop Nut Corporation of America
Dept. R16-CM, 2330 Vauxhall Road, Union, N. J.

Please send me the following free fastening information:

☐ Rollpin bulletin

☐ Elastic Stop Nut bulletin

☐ Here is a drawing of our product. What fastener would you suggest?

Name_____ Title_____

Firm_____

Street_____

City_____ Zone_____ State_____

STRESS and STRAIN...

An ingenious Chem.E., hard-pressed to pass a P-Chem. prelim, is reputed to have perpetrated the following cheating scheme: Instead of using his exam booklet to answer the questions, he wrote a long letter to his mother in the booklet and turned it in to the proctor's desk. He then proceeded to the library, took a clean booklet, answered the questions, placed the completed prelim in an envelope and mailed it to his mother. Immediately afterward he rushed up to his instructor loudly bemoaning that he has made a terrible mistake —"I found the exam so easy that I finished it in half the alloted time, and, not wanting to be the first one to leave the room, I wrote a letter to my mother in an extra booklet in the spare time. But, horror of horrors, I gave you the letter and mailed Mom the exam: what shall I ever do?"

The instructor, a typical soft-hearted professor, was supposed to allow the student's mother to return the prelim by mail without loss of credit. Actual outcome? Mom got a 93 in the course and son is attached to the Chemical Warfare Company of the Fourth Infantry.

* * *

Coed: "Am I the first girl you ever kissed?"

E.P.:"Now that you mention it, you do look familiar."

* * *

You know, they also have a slogan in Russia: "Vote for the party. The life you save may be your own."

* * *

Girls are like newspapers. They all have forms, they always have the last word, back numbers are not in demand, they have great influence, you can't believe everything they say, they're getting thinner than they used to be, they get along by advertising, and every man should have his own and not try to borrow his neighbor's.

Looking coldly at the man who had just given him a nickel for carrying his bags twelve blocks, the little boy said, "I know something about you."

"What?" asked the man.

"You're a bachelor."

"That's right. Know anything else about me?"

"So was your father."

* * *

Voice on Phone: "Hello, is this the Ithaca Gas Works?"

Professor: "No, this is the University Public Speaking Department."

Voice: "Well, didn't miss by much."

* * *

A man named Joe Hogsbristle appeared in court to have his name legally changed. The judge nodded, "What name do you want to take?"

"Frank Hogsbristle. I'm sick and tired of hearing people say, 'Hi, Joe, whattya know'."

* * *

A fugitive scientist from a horror picture dreamed up a serum that would bring life to inanimate objects. He surreptitously tried it on a statue of a great general in Central Park. The statue gave a quiver and an instant later, came to life and climbed down from his pedestal. The scientist was overjoyed "I gave you life!" he exurted. "Now tell me, General, what is the first thing you are going to do with it?"

"That's easy!" rasped the general, ripping the gun from his holster, I'm going to shoot about two million pigeons!"

* * *

Engineer: Why do you go out with that sad looking girl?

Lawyer: She's different from other girls.

Engineer: Is she?

Lawyer: Yes, she's the only girl who'll go out with me.

* * *

It was during prohibition. The railroad station was packed with a gay throng. Over at one side of the waiting room stood a quiet little man fidgeting about, and attempting to hide himself from the crowd. A federal agent noticed that the man had something in his pocket from which drops were falling in slow trickles. The fed., with a gleam in his eye, put a finger out under one of the drops, caught one, and tasted it.

"Scotch?" he asked.

"Nope," replied the stranger, "Airedale pup."

* * *

'We've got a case of beri-beri up here. What'll we do with it?"

"Give it to the engineers. They'll drink anything."

* * *

Sign in a local shop: Our Lingerie I s the Finest. Smart Women Wear Nothing Else."

* * *

"I'll see you," said our hero as he laid down four aces in a game of strip poker.

* * *

Dear Pop:

Everything fine at school. I'm getting lots of sleep and am studying hard.

Incidentally, I'm enclosing my fraternity bill.

Your son,
Pudge

Dear Pudge:

Don't buy any more fraternities.

Your pop,
Pop

* * *

Al: "Is my face dirty, or is it my imagination?"

John: "Your face is clean. I don't know about your imagination."

* * *

"Is it a modern farm house?"

"No, five rooms and a path."

* * *

C.E. Prof.: "Explain the operation of a steam shovel."

B.F.: "Don't kid me, you can't shovel steam."

PHOTOGRAPHY AT WORK—No. 11 in a Kodak Series

Kodak

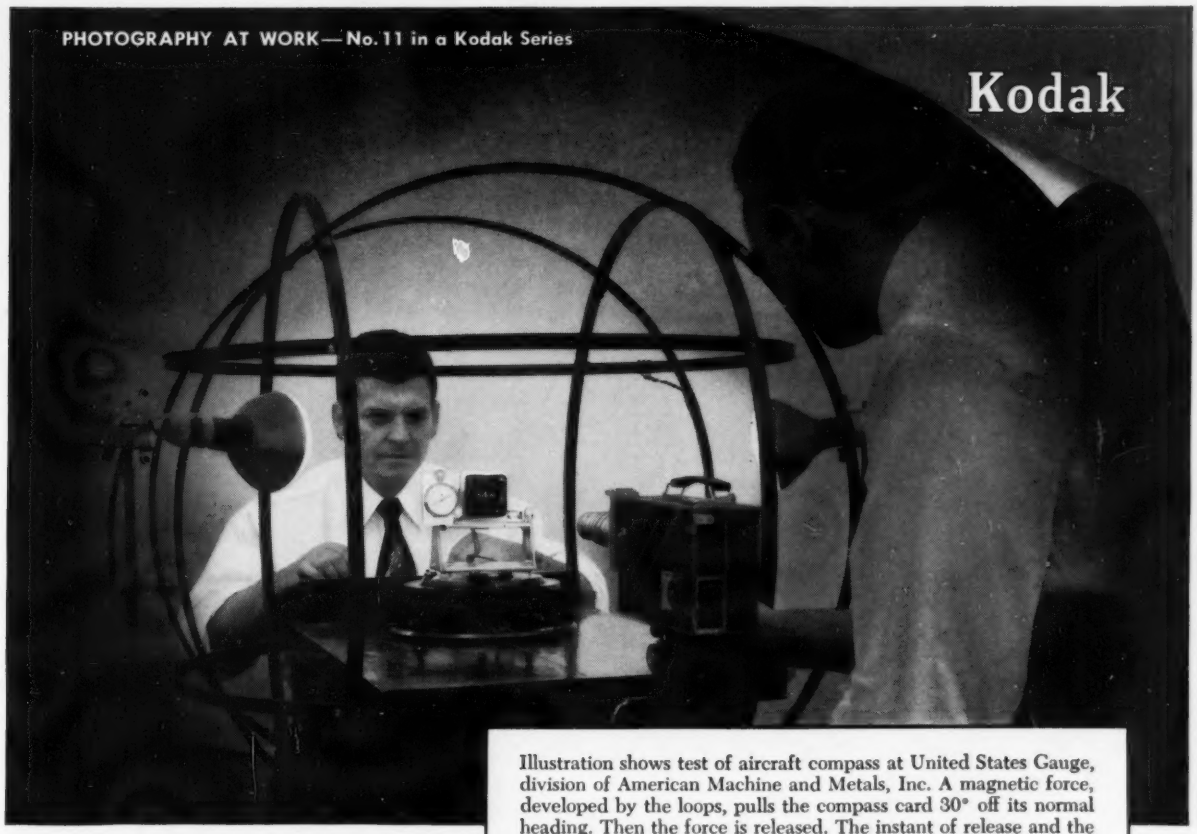


Illustration shows test of aircraft compass at United States Gauge, division of American Machine and Metals, Inc. A magnetic force, developed by the loops, pulls the compass card 30° off its normal heading. Then the force is released. The instant of release and the moment the compass recovers by 5° are both recorded on the film—become positive evidence of proper performance.

Wanted: an inspector with a split-second eye —*photography got the job*

A difference of 2/10ths of a second means the compass passes or fails. So the maker pits it against a stop watch—gets definite proof of performance with movies.

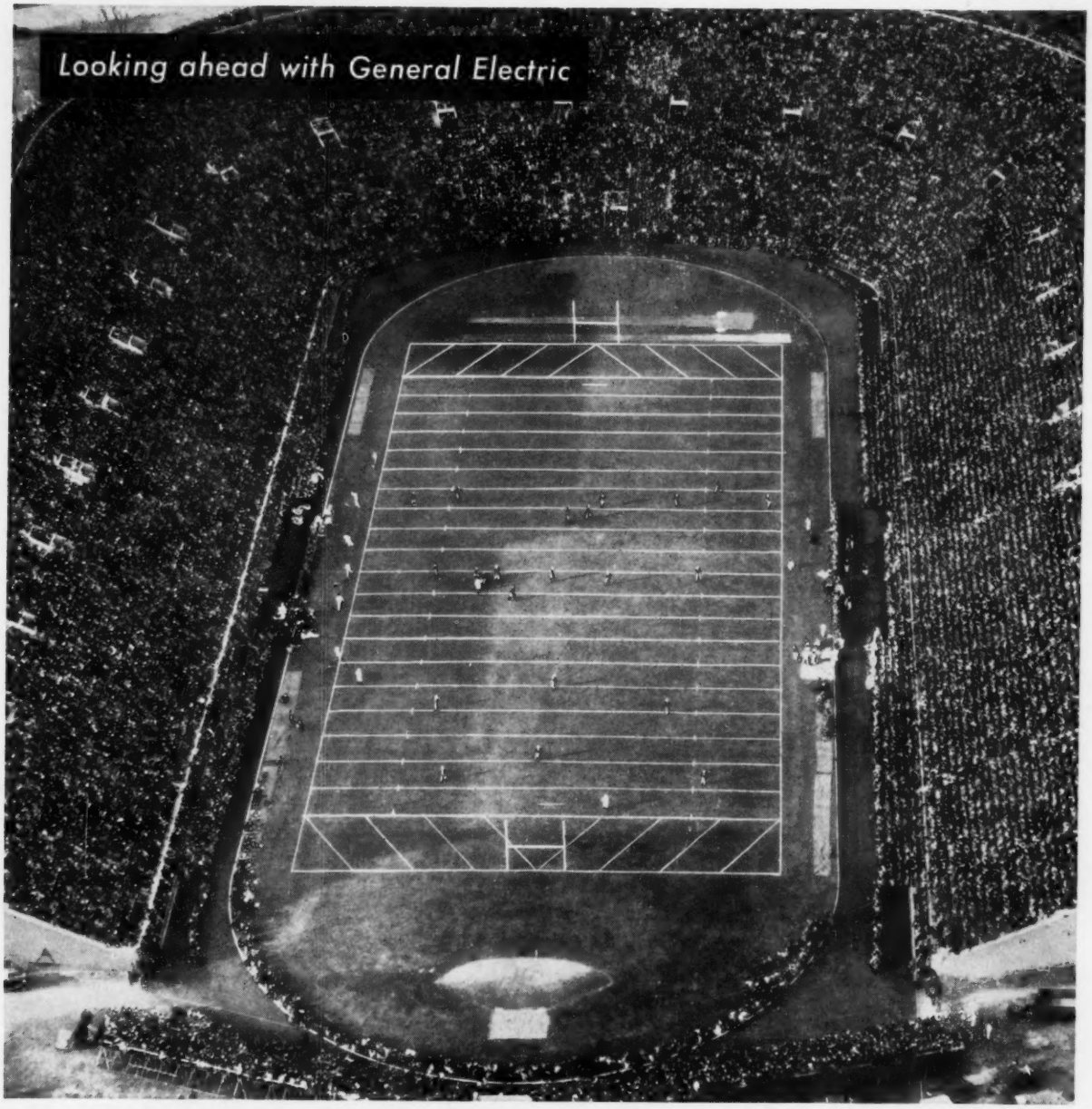
Uncle Sam said this aircraft compass must respond by 5 degrees in not less than 1 second or more than 1.2 seconds. That's only 2/10ths of a second leeway—far too little for human hands and eyes to catch the action accurately.

So, side-by-side, the stop watch and compass act their parts before the movie camera. Then individual frames along the film show the precise instant that the 5-degree mark is reached.

Product testing and quality control are naturals for photography. They are typical examples of the many ways photography works for businesses, large and small. It is improving production, saving time, reducing error, cutting costs.

Graduates in the physical sciences and in engineering find photography an increasingly valuable tool in their new occupations. Its expanding use has also created many challenging opportunities at Kodak, especially in the development of large-scale chemical processes and the design of complex precision mechanical-electronic equipment. Whether you are a recent graduate or a qualified returning service man, if you are interested in these opportunities, write to Business & Technical Personnel Dept., Eastman Kodak Company, Rochester 4, N. Y.

Eastman Kodak Company, Rochester 4, N. Y.



45,000 G-E people working on jobs created by new products since 1945 could almost fill Princeton's Palmer Stadium.

In 9 years, new products created G-E jobs for enough people to fill a football stadium

Coming years promise even more progress.

One out of every five people at General Electric owes his job to products G.E. didn't make before 1945. And the future looks even brighter.

We can see new and exciting possibilities in many different fields. Atomic energy, jet engines, electronics, silicones—all promise to create new products, new processes, and new jobs.

As we see it at General Electric, America's industrial progress in a free economy is not only continuing, it's rapidly accelerating.

Progress Is Our Most Important Product

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